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Multimodal Transportation: Development of a Performance-Based Planning Process

Prepared for:

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Table of Contents

Summary of Findings

This is the draft Final Report for NCHRP Project 8-32(2), *Multimodal Transportation: Development of a Performance-Based Planning Process.* The purpose of this report is to document the research and findings resulting from this project. A separate *Performance-Based Planning Manual* has been produced which organizes the findings and recommendations of the project into a user-oriented guidebook format.

This project was conducted in two distinct phases, the first of which began in 1995 and concluded with delivery of a Draft Final Report in August 1996. The second and final phase of the project began in April 1997 and resulted in preparation of an Interim Report (February 1998) and a *Research Results Digest,* published by TRB in July 1998. Remaining products of the research project include this Final Report and the *Performance-Based Planning Manual.*

■ ES.1 Contents of this Report

This Final Report includes a discussion of the project objectives and work plan, (Section 1.0), a summary of the 10 case studies (Section 2.0), a summary of the four workshops conducted around the country (Section 3.0), and identification of further research or product development that are suggested by the results. Appendix A contains detailed documentation of the case studies conducted during Phase II of the project. Appendix B provides a copy of the Phase I Draft Final Report which was originally delivered in August 1996. Note that the *Performance-Based Planning Manual* has been prepared for publishing under separate cover, incorporating the *Performance Measures Library* as an appendix.

■ ES.2 Summary of Findings and Recommendations

NCHRP Project 8-32(2) involved several years of active research into the application of performance measurement to the multimodal transportation planning process. In two distinct phases, the project team conducted some 20 case studies and eight formal workshops to identify the extent to which public agencies and private transportation organizations have incorporated performance measurement into their planning decision-making. The team reviewed an extensive amount of written material, extending beyond the transportation sector and beyond the normal perspective of governmental agencies as well. The team also took part in many discussions with practitioners across the United States and Canada to identify their interests, needs, and implementation experiences with application of performance measurement to their planning missions.

Our findings are broad ranging, and different users of this research will undoubtedly find some findings and recommendations more useful and applicable to their situation than others. This is at least in part due to the fact that the term "performance-based planning" itself is quite broad, and means different things to different people. The field of performance-based planning, if such a thing can be said to exist, is expanding rapidly as interest grows and agencies initiate efforts to design and implement performance monitoring and reporting programs.

One of the most apparent results of the research is that even discussing performance-based planning with others requires that the parties to the discussion first agree on *what* exactly they are talking about. Workshops and entire conferences have been devoted to discussion of a range of distinct applications or contexts for performance measurement, from planning to management to budgeting. It has become clear that there is still much room for refinement of the terminology and greater clarity about the intended application and purpose of any given performance measurement undertaking.

That said, it is the purpose of this final project to report on the potential usefulness of performance measurement in the context of multimodal transportation system planning and decision-making, and to present that information in a user-friendly guidebook format. While that context can certainly be broadly construed to include budgeting, management, agency performance review, etc., we hope to focus our results on those fundamental activities and elements of the planning process that typically lead to identification and adoption of transportation policies, programs, and projects for a jurisdiction or authority.

General Findings

- **Above all, integration of performance-based methods into the planning process remains a desirable and important objective.** Evidence from within and outside of transportation agencies points to the need for improved practices, and the value which can be expected in return. Today, there are more factors influencing transportation decisions than ever before, such as international trade and competition, deregulation and modal competition, environmental regulation, and the pluralistic nature of most transportation decision-making processes. We have a need to serve an increasingly diverse customer base with the transportation system, and many agencies have embarked upon new or different missions emphasizing preservation, management, and user-orientation. Performance-based planning remains an important strategy in addressing these changing demands, independent of the presence or absence of ISTEA management systems.

- **States and MPOs are looking for guidance rather than regulation**. Flexibility of the methodology, and a great degree of self-determination rank high among their needs. More specifically, the impact of the current funding environment on agency capabilities cannot be overestimated. Agencies are under pressure to do more with fewer resources, and will not react positively to new mandates or structured planning regulations. This has clear implications for the way in which performance-based planning is framed and deployed. It is important to demonstrate the value of performance measurement to the planning and decision-making processes.

- **Implementation of performance-based planning methodology in the transportation planning context is an evolutionary process.** Most agencies that have implemented a performance-based approach have made many changes along the way, including fundamental changes in the structure of their processes and in the way performance measures are used. The implication is that agencies that pursue performance-based planning must be prepared to stick with it for a considerable duration. Not only does it take multiple budget cycles to design and implement a program, but results and benefits also take some time to clearly materialize. Thus, agencies need to secure solid support from executive management to ensure continuation of the program.

- **In many instances, programs that started out comprehensive in nature have been refined to provide a smaller, more focused method of measuring system condition and performance.** The range of elements or dimensions that are monitored has, in many cases, been incrementally refined to focus on those over which the monitoring agency has the greatest interest and degree of control. This trend has implications for refinement of the typology for performance-based planning which was proposed and refined in the first phase of the study. While most agencies continue to be interested in tracking the contribution of their activities towards broad societal objectives such as economic development, livability, or environmental quality, they have become more realistic and pragmatic about how to monitor and report that contribution. Advances have been made, for example, in selecting performance measures to distinguish between those outcomes over which an agency does or does not exercise direct control; agencies continue to monitor outcome and performance in areas where they do not exercise sole control, but can use performance measures as diagnostic tools to promote better understanding of the underlying causes, and thereby, solutions to those problems.

- **Performance measures are being applied in a variety of contexts,** as noted above. These contexts include system planning, program prioritization, organizational accountability, budgeting, personnel management, etc. This research project focuses on application of performance monitoring and evaluation methods to improve the linkage between system goals, policies, and actions as embodied in the various system planning documents. The methods are intended to aid in the identification of programs, projects or services that most directly address those goals, and to monitor the actual outcome of plan implementation and thus provide feedback to the subsequent planning processes.

- **The research findings do not warrant any endorsement for using performance measures as a way of replacing the current transportation project prioritization and selection processes with purely analytical, quantitative methods**. Many participants in the case studies and workshops emphasized their viewpoint as practitioners that it is undesirable to attempt to replace an inherently complex, political process with one that is overly simplified or purely quantitative. While performance measurement can bring higher quality information to the decision process, it is most valuable as an input to the existing processes, and should not replace those more deliberative, qualitative processes.

- **In most transportation agency applications, performance-based approaches have not yet had a significant impact on the ultimate outcome of decisions.** In many states or regions there is a backlog of approved projects competing for selection and funding.

New projects that might rank highly under a performance-based approach compete poorly in current decision-making models against projects that have already received political consensus and/or broad support. The structure of policy-making has not changed substantially in most agency situations. This appears to be true even though the outreach to external stakeholders and customers in the planning process has improved dramatically in many locations due to the influence of ISTEA and other statewide and metropolitan planning rules and guidelines. We do not believe this is a sign that performance-based planning methods cannot have a significant impact on the decisions or the outcome of those decisions. Rather, there is likely a necessary passage of time during which the performance-based methods become institutionalized and gradually will exert more influence over decision-making. **At present, most practitioners seem to agree that the most they can expect to accomplish in the near term is to provide better-quality, more goal-relevant information to an inherently political decision-making process.** By educating and informing the public, in part through the use of customer-oriented outcome measures, we should also expect to see incremental changes in the decision-making models that favor more objective evaluation and debate.

The refined model for performance-based planning incorporates a number of these more recent findings, as well as some of the basic ideas that were tested in the first phase of the project. For example, it is widely agreed now that the system policies, goals and objectives are a critical starting point for development of a performance-based approach. It is most important for agencies to establish the "why" and "what" of the process before tackling the "how," although this principle is not always followed in practice. The concepts of "outcome" measures and the important role of customer perception and satisfaction are now well established.

Specific Implementation Issues

The *Performance-Based Planning Manual* contains implementation guidance based on the research. The following major findings are worth noting here:

- **There are inherent differences between freight and personal transportation, and between private-sector freight transportation activities and those administered or provided by the public sector.** One important difference is the timeframe for making decisions, and the duration of commitment to a selected decision or course of action. The freight industry, and the private sector in general, makes decisions which are more responsive to changing market conditions. They may also change strategy more frequently than is *perceived to be* desirable or feasible in the public sector. Thus, performance measures aimed at freight transportation should distinguish between those components of the system that are reasonably provided by the public sector, and those which should remain the domain of private industry. Public agencies focus on providing access to public facilities and on ensuring the dependability of those facilities, while the private sector focuses on more dynamic investments which permit them to achieve their business objectives in light of changing market realities. The methodology should observe this division of function where it is valid. As a further note, agencies should take a hard look at private industry's willingness to make more frequent and rapid changes to their system of performance measurement. The common wisdom has been that public agencies should not (or cannot) respond as quickly to changing external forces. Yet some of the research suggests that a more flexible approach and greater openness to modification of data collection, analysis, and reporting procedures might allow public planning agencies to evolve and respond more quickly to changing needs and expectations of their customers.

- **A performance-based planning process should include both performance measures which are broad enough to guide system planning, and more specific evaluation criteria which improve the ability of agencies to select and prioritize specific projects or programs.** The relationship between performance measures and evaluation criteria, and the linkage of both to broad goals, should be clear. The different time horizon of long-range plans and more near-term project planning activities makes it a challenge to achieve this linkage, however. Decision-makers, the public, and the system planners all have a different time horizon. This problem can be overcome in part by assuring that near-term evaluation criteria are directly related to longer-term measures and goals, and in part by using the process to periodically reevaluate and amend as necessary the long-range planning documents. Goals and performance measures need to be kept reasonably current with users' needs, and the planning process needs to be able to react more quickly to changing needs. Performance-based planning can be an important process for monitoring, evaluating, and modifying the implementation of long-range plans.

- **While the use of more focused measures does lend itself to better informed planning decisions at the project and program level, it raises the question of the importance of user-specific issues to those who are responsible for the entire transportation system.** Again, by looking to the states and metropolitan areas that have persevered through several cycles of performance-based measurement and planning, we can see that the level of disaggregation of information needs to be carefully linked to the type of decisions that are to be based on the information. Agencies have begun to develop and refine more structured approaches in which information of a certain type (e.g., safety-related data) can be collected in one format but reported at a variety of levels of aggregation, depending upon the decision-making context in which it is used. We are seeing a trend towards a structured, hierarchical framework that provides information aggregated to the proper level of the organization at which the information will be used. This finding provides guidance on the selection of measures, data sources, and analytical methods that are useful across a broad range of applications.

- **In order to be useful at a variety of levels of planning and decision-making, the approach needs to offer performance measures at the appropriate level of aggregation and with the appropriate information content.** For example, some agencies have designated a relatively small set of core measures for executive-level decision-making, supplemented by related but more specific and disaggregate secondary or tertiary measures intended to support decision-making at the program or service delivery levels. What is important is that these measures be related or aligned along some dimension that has strategic significance to the agency in terms of its goals and policies.

- **This hierarchical model recognizes that there are different information needs for different users and owners/operators of the system.** The over-arching policies and goals to which the agency's actions are dedicated are common to these different perspectives, and therefore the performance measures, although different in construction and information content, need to align with a defined, limited set of strategic categories. The model recognizes that the frequency of data collection and reporting of measures may vary significantly depending upon the level at which the measure is used. And, the analytical models or data manipulation techniques used to refine data into performance measures will vary depending again upon the end user of the measure.

Areas Where Further Improvement is Desirable

Continued opportunities for discussion and debate among practitioners will be valuable if for no other purpose than to force some clarity of intent and context. Beyond this, however, there are some specific areas where future research would prove useful to the development and implementation of performance-based planning methods. These are discussed in somewhat more detail in Section 4.0 of this report, and briefly summarized here.

- **Development and distribution of analytical tools:** Generation and analysis of system performance data remains a major obstacle to implementation of the outcome-based, user-oriented performance measures that are important to performance-based planning. Not only is there a continuing need to refine the analytical methods and tools, there is a need to see that once developed, these tools are made more readily accessible to a range of users.

- **Data collection**: Distinct from methods to synthesize, forecast, and analyze data, there are fundamental obstacles to the collection of data that will support performance measures beyond those traditionally collected by transportation system owners. Deployment of ITS technologies promises to eventually improve the quality and lower the cost of a broad range of transportation data, but work is required to determine how to best capture these data sources for planning and evaluation purposes. At the same time, there exists a potential for "data overload" if too much information becomes available and agencies are not able to identify that smallest amount of data that best addresses their information needs.

- **Dissemination of information**: The research conducted for this project points out the ease with which information can become dated in a rapidly expanding field. Performance-based planning is being explored and implemented by a rapidly growing number of transportation planning and operating agencies. A more rapid and streamlined means of collecting, organizing, and disseminating the experiences of these agencies, as well as their response to research results such as these, would facilitate more uniform and timely development of ideas. In Section 4.0 we recommend utilization of electronic media to support more timely two-way communication of between interested parties.

1.0 Research Objectives and Work Plan

1.1 Research Objectives

NCHRP Research Project 8-32(2) was conceived to support a new era of transportation planning efforts at the federal, state and regional levels. There are several significant factors that have broadened the goals and objectives for transportation investment, and have expanded our awareness of the diverse set of customers that the transportation system serves. These factors include:

- The ISTEA legislation with its emphasis on multimodal solutions and its long-range planning, financial planning, management system, and flexible funding provisions;
- Heightened concern about the most effective use of scarce resources in an era where traditional transportation funding sources are not generating sufficient revenue to meet perceived needs, yet the public continues to be in a "tax revolt" mood;
- Increased awareness and concern about the role of transportation in supporting economic competitiveness, as changes in the national and global economies place new demands on the transportation system, especially for freight and goods movement, and international trade agreements open new markets;
- Environmental laws and regulations and particularly the Clean Air Act and Energy Efficiency Act;
- Social and equity concerns reflected in legislation such as the Americans with Disabilities Act;
- Growth management, congestion management, and transportation/land use laws and regulations; and
- A variety of new technologies offering a wider range of transportation solutions including Intelligent Transportation Systems (ITS), alternative fuel vehicles, high-speed rail, etc.

NCHRP 8-32(2) was conducted in two phases. The first phase focused on searching for applicable examples of performance-based planning in industries and sectors other than transportation planning. There was also a review of state and MPO plans and programs to determine the degree to which ISTEA had begun to impart any element of performance measurement. The objective of Phase I was to develop some common typology of goals and objectives, and to establish a framework for application of performance measures to the multimodal planning process. These objectives were accomplished through a detailed literature review, through 10 case studies covering a broad range of transportation planning contexts and situations, and through several workshops at the regional and national level.

The second phase then focused in on identified cases of application of performance measurement, and identified examples of successful practices. A second round of case studies was conducted, this time of agencies selected specifically for their range of experience and recent application of performance measurement to their planning processes. Another round of workshops was held, this time in conjunction with professional meetings or conferences. These workshops served to present interim findings of the research and obtain feedback from planners, administrators, academics, and others.

This second phase of work helped to build on the Phase I findings, and to more clearly focus the objectives of the research. The following objectives were laid out as the project transitioned from Phase I to Phase II:

- More clearly establish the benefits to be gained from performance-based planning, beyond the law or other mandates. Why is this a better way to do business? Why should agencies find value in this approach as compared to what they do now?

- Concentrate on giving states and MPOs guidance in relation to performance-based planning, opting for a theme of helpfulness in contrast to a recent environment of regulatory mandates.

- Highlight the role of performance-based planning as an aid to improved decision-making, not as a replacement for existing processes.

- Make clear the need to derive performance measures from appropriate goals and objectives that have undergone public review and acceptance.

- Provide guidance in the identification and selection of specific performance measures, providing users with a menu of realistic candidate measures for each of several defined goals or areas of concern.

- Provide for differences in geographical and institutional coverage corresponding to the different needs of state, MPO or local levels of planning responsibility.

- Resolve concerns about the cost of data collection by incorporating existing data sources into the methodology and framework, tying specific performance measures to known data sources where possible.

- Identify next-generation data sources, analytical methods, and performance measures, demonstrating techniques for utilization of data collected through technology such as traffic surveillance and monitoring systems.

- Present solutions to process- or institutionally-oriented problems, not solely to the technically-oriented problems.

- Target specific information gaps identified in Phase I, such as freight-related measures and data, "user-friendly" analytical methods, existing data sources to meet immediate needs, and institutional obstacles.

1.2 Research Plan

The following summarizes the research plans adopted for both Phases I and II.

Phase I

- **Literature Review –** We conducted a thorough inventory of the basic elements which comprise the performance-based process, including example goals, objectives, and performance measures, and the decision-making and planning approaches driven by the measures. Examples were drawn from the public and private sectors, from transportation and non-transportation fields. Sources included published transportation plans, management information systems work plans, other research reports, and follow-up interviews with practitioners.

- **Case Studies –** The case studies were an important source of information in Phase I. A broad range of transportation situations was included in the case studies, from statewide multimodal transportation planning efforts, to regional and facility-level implementation projects. We included multi-state undertakings, public-private partnerships and turnkey projects.

- **Typology of Goals and Objectives –** We developed and continuously refined a typology of goals and objectives, establishing relationships between the goals, objectives, and measurements of transportation system performance. The purpose of the typology is to clarify how the selection of appropriate performance measures is a function of the particular goals and objectives, and further, how the data needs are in turn driven by the goals, objectives, and measures. The linkages between these elements of the process, and the feedback loops integrated into the process, are the defining features of a performance-based planning process.

- **Analytical Methods and Data Sources –** In Phase I, this was limited to identification of analytical methods which could be used to facilitate a new generation of performance measures. These methods include data collection, storage, manipulation, and analysis procedures. A broad range of possible techniques, and potentially desirable methodological enhancements, were identified in order to accommodate a wide range of agency resources and needs.

- **Peer Review and Feedback –** We convened four advisory meetings to uncover examples of experience with performance-based planning techniques and to solicit feedback on the research as various points along the way. During Phase I, three regional advisory meetings were conducted, in Cincinnati, Portland (OR), and Atlanta. These meetings had a regional focus, involving participants from state DOTs, MPOs, transit authorities, and private owners/operators. The final advisory meeting was held in Washington DC, in April 1996, and include numerous participants from agencies and organizations with a national perspective, as well as additional local, regional and state agency participants.

The findings of Phase I were presented in a Draft Final Report, which appears in Appendix B to this report.

Phase II

The following work steps were conducted in Phase II:

- **Document Phase I Results –** The key findings of Phase I were summarized in a Research Results Digest, formally published and released by TRB in 1998.

- **Define the Scope and Content of the Performance-Based Planning Manual –** The research team defined the key product of the Phase II research, taking into consideration the Phase I results and Panel input. The manual outline was refined over the course of Phase II, incorporating further comments from the Panel as well as comments received at the Phase II workshops in 1997. The Manual draws upon examples to provide realism and context in illustrating how others have approached performance-based planning, obstacles they encountered, and how they overcame those obstacles.

- **Select Case Study Sites and Conduct Research –** The Panel confirmed the plan to build the final products around a series of focused investigations into current efforts of states, MPOs, and others in the application of performance-based planning processes. Case studies were completed of these 11 agencies/organizations:

  1. Florida Department of Transportation;

  2. Oregon Department of Transportation (focusing on the Intermodal Management System);

  3. Washington State DOT (focusing on the Eastern Washington Intermodal Transportation Study);

  4. Vermont Agency of Transportation;

  5. Capitol District Transportation Authority (Albany, NY MPO);

  6. Portland Metro (MPO);

  7. East-West Gateway Coordinating Council, (St. Louis, MO MPO);

  8. Metropolitan Council (Twin Cities, MN MPO);

  9. United Parcel Service;

10. Amtrak; and

11. Miami Valley Regional Transit Authority (Dayton, OH).

Summaries of the case studies are in Section 2.0 of this report, and the detailed case studies are in Appendix A.

- **Workshops** – In addition to the case studies, the research team conducted workshops at four points during the Phase II contract to discuss our findings and progress with a cross section of transportation planning professionals. These were organized as "breakout sessions" attached to regional and national conferences and meetings that attracted an appropriate audience. The main purpose of these meetings was to solicit feedback from the likely users of the research results. The research team conducted workshops at the following locations:

  – Essex, Montana, at the 1997 TRB Multimodal Planning Committee Summer Meeting

  – Boston, Massachusetts, at the 1997 Institute of Transportation Engineers International Meeting

  – Saratoga Springs, New York, at the 1997 Association of Metropolitan Planning Organizations (AMPO) National Meeting

  – Washington, DC, at the 1998 TRB Annual Meeting

  Details of the workshops and their associated findings are presented in Section 3.0.

- **Prepare Performance Measures "Library."** – An important component of the overall research products is the Performance Measures Library, a reference compendium on alternative performance measures. Its purpose is to offer practitioners a concise look-up guide of potential measures.

- **Prepare Interim Report** – An Interim Report was prepared approximately 10 months into the Phase II work to document the progress and findings of the research to date. This report was presented to the Panel at a March 1998 Panel meeting in Washington, DC.

- **Develop Performance-Based Planning Manual** – The research team developed a preliminary draft Performance-Based Planning Manual for Panel for review and comment. The final Manual will be bound separately from the final Project Report, and is intended for distribution to a wide range of potential users.

- **Prepare Final Project Report** – The Final Project Report documents the overall process that was followed in conducting the research and completing the manual. The objectives of the final report are to formally document the work done in the research effort, and to summarize any special problems that were encountered and solved or discoveries that were made. Whereas the Manual is intended to be more user-oriented, concise, and to the point, this Final Project Report includes more background about the case studies and the research project in general.

2.0 Case Studies

The case studies conducted for Phase II of this research project reflected public and private experiences with performance-based planning. The cases were chosen because of specific characteristics that allowed the project team to generalize from this experience to other contexts. These case studies included state departments of transportation, metropolitan planning organizations, transit and intercity rail passenger service providers, and a private firm specializing in goods transportation. In each case, field visits provided an in-depth review of the institutional and technical foundations for performance-based planning. The results of these case studies provide important insights into the challenges and opportunities associated with such planning, and lead directly to recommendations and guidelines incorporated into the *Performance-Based Planning Manual*.

The importance of each case study to this research project is described briefly in the following sections. The completed case studies are provided in Appendix A to this final report. It is important to note that these case studies were conducted during the period April 1997 through February 1998. Most of these agencies have continued to develop and refine their performance measurement and reporting methods and programs since that time, and these case study summaries do not reflect the changes and improvements that may have been made since early 1998.

■ 2.1 Metropolitan-Level Examples

Three case studies focused on performance-based planning at the metropolitan level. These case studies included: Albany (NY), St. Louis (MO), Portland (OR), and Minneapolis/St. Paul (MN).

Albany, NY

The Capital District Transportation Commission (CDTC) in Albany, NY was one of the earliest metropolitan planning organizations to use performance measures in a comprehensive way. As part of a comprehensive update to the long-range regional transportation plan, the CDTC adopted a set of "core performance measures" that reflected a total cost-accounting perspective on transportation system impacts. Importantly, this cost accounting as reflected in the performance measures includes not only those impacts that can be monetized, but also those that do not involve a pecuniary cost. For example, travel time for commercial and on-the-job travel is monetized, while all other travel time is quantified, but not transformed to monetary terms.

The approach used for developing a universe set of performance measures was an important characteristic of the success of the Albany effort. Nine task forces were established to provide additional focus in key planning areas such as arterial management and transit futures. The task forces developed supplemental performance measures that could be used for tradeoff analysis of specific plan options. These supplemental measures had to be related directly to the core performance measures. This process was successful in linking broad system performance measures to criteria for evaluating cost-effective strategies in individual applications.

Lessons Learned from Albany

Although the conceptual approach toward performance-based planning in Albany is widely regarded as a national model, participants did not find that it had much influence on final decisions. Two of the task forces, however, those focused on Transit Futures and Expressway Management, felt that the performance-based approach was particularly well-suited to the types of options they considered.

The minimal impact on ultimate decisions is not surprising. Participants explained this by relating these decisions to the structure of policy making (i.e., who makes the decisions and who they represent). This is likely to be true for any transportation investment decision process where tradeoffs must be made. In addition, a backlog of TIP projects meant that new projects that surfaced from the performance-based planning approach would have to compete with projects which had already received political consensus. Again, this is something not likely to occur in any political process. The specific lessons learned from the Albany case study were:

- Adoption of performance-based planning for a planning process will be evolutionary, that is, there will be a period of time before the new approach begins to have an impact.
- Performance measures should be viewed as a way to assist decision-making, not guide it. One could argue this is the basic function of planning in general.
- Developing a set of core performance measures to which everyone agreed assured consistency among the many different groups as they proceeded toward recommended policy and strategies.
- Performance-based planning is perhaps more participatory than traditional models. This implies that great efforts need to be made to "open" the process to a broad range of participants. This also means that the process must be understandable to these participants.
- Long-term commitments for data collection and analysis are necessary for performance-based planning to work.

St. Louis, MO

The East-West Gateway Coordinating Council, the MPO for St. Louis, has been exploring the use of performance measures in planning for at least the past four years. Importantly, the long-range transportation plan identified outcome-based performance measures that related to the social, economic, and environmental vitality of the region. These measures were used in three planning initiatives with varying levels of success.

The first initiative was a major investment study (MIS) where the performance measures were used to compare and rank modal investments. Measures were identified as part of the evaluation process, but did not seem related to project-specific impacts nor the availability of data. A second effort in the MIS to incorporate performance measures resulted in 50 measures being identified.

The second initiative was to use performance measures in project prioritization for the TIP. Projects were ranked by their relation to regional goals (and hence performance measures) and their cost effectiveness.

The third initiative was incorporating performance measures into a regional freight planning study. A list of 28 performance measures was identified which related to regional freight objectives. Importantly, industry participants played an active role in defining these measures. These measures will be used on a periodic basis to produce a "report card" for freight mobility in the region.

Lessons Learned from St. Louis

The St. Louis case study provides an interesting example of the difficulties associated with performance-based planning if realistic constraints are not placed on the parameters at the outset. For example, many of the participants criticized the process because of the unwieldy number of performance measures that became part of the process. Not only does this represent an information "overload," but the data collection effort can become unmanageable very quickly. With regard to the MIS, one of the areas of concern was the linkage between performance measures and likely project impacts. Because of the large number of measures as well as the lack of data to support them, the exercise was considered unsuccessful. Also, the performance measures were incorporated too late into the MIS process. This created difficulty in relating the measures to project concerns.

In the TIP prioritization case, the performance measures were not adequate for measuring progress toward overall goals. Another constraint was the very nature by which projects are selected. Some participants felt that the listing of specific prioritization criteria limited the number of projects that were submitted to the TIP process. This possibly resulted in a set of actions that did not best address all of the MPO's priorities.

The freight planning annual "report card" provides the best successful experience in St. Louis with performance-based planning. The final set of recommended measures was chosen based on two criteria: ease of data collection and relationship to regional significance. By using these criteria, the performance measures reflected a strong level of implementation feasibility. A comparison with the original planning performance measures showed a relationship between the two, that is, the freight measures related closely to the regional measures.

The specific lessons learned from the St. Louis case study were:

- Although often difficult to gain consensus on which measures are "the best," focusing on a few good performance measures provides more targeted information to decision-makers. Too large a number of measures can confuse the decision-making process as much as inform it.

- Monitoring system performance along the lines defined by the performance measures requires substantial, periodic data collection and analysis. Any set of performance measures that results in an overwhelming data collection requirement will be quickly abandoned.

- The freight "report card" illustrates the need for incorporating stakeholders and system users into measure definition. In some sense, this assures the relevance of the performance measures to the actual use of the transportation system.

- Technical in-house capacity to use performance measures is critical. This not only relates to the credibility of the process as seen from other actors in the process, but also translating the data collected into information that can be used in decision-making.

Portland, Oregon

Metro is the MPO for Portland, Oregon. While Metro is involved in more than one application of performance-based approaches (they are a partner, with ODOT and the Port of Portland, in the Oregon Intermodal Management System, for example) this case study focused on Metro's application of performance measurement to the regional transportation planning process.

Relative to many other MPOs, Metro has a higher degree of legislative and statutory strength behind its planning activities. Oregon's administrative rule for transportation planning, the Transportation Planning Rule (TPR), requires the quantification of goals and objectives as part of the process. The Regional Transportation Plan (RTP) is framed by the more comprehensive "2040 Growth Concept," which calls for emphasis on access to the central city, regional centers, intermodal facilities, and industrial areas. There is a secondary emphasis on access to other nodes such as town centers, communities surrounding transit stations, etc. As can be seen, the RTP has a very strong land use component built in, by virtue of the orientation towards access as opposed to mobility.

Metro has a relatively larger amount of resources dedicated to transportation analysis, and is known for their innovations in development and application of analytical models for multimodal planning and analysis. This capability sets Metro apart from many MPOs at present, and also tends to have a large influence on the performance measurement effort. In particular, Metro has developed measures of accessibility that are fairly advanced, and which are based upon a spatially-referenced data system and travel model. The advantages of their approach include providing a measures of access to opportunities that are relatively mode-neutral.

Lessons Learned from Portland

- Metro feels the decision-making process is better informed, more open, and as an indirect result, more lengthy. Planners should anticipate that implementation of performance-based approaches will draw out the time required to evaluate and reach decisions, not decrease it.

- A high degree of public involvement in the planning process has driven the user-based perspective. You cannot expect to have one without the other, i.e., you cannot accurately gauge what the public values if they are not heavily involved, and you cannot involve them without providing feedback on predicted system outcome in measures that are meaningful to the users and general public.

- Performance-based planning in a growth-management environment such as Portland's has helped integrate land use and transportation decisions. It has also reduced some of the conflicting objectives between land use and transportation plans. For many, this linkage is the "holy grail" of planning, and a performance-based approach that considers the land use impacts of different transportation investments will help achieve this objective.

- On the technical side, Metro has gone further than most agencies in devising and implementing quantitative measures of mobility and accessibility that are computationally complex, but the results of which are still relatively intuitive to the user. Metro cautions that many accessibility measures they have considered are simply not possible given the availability and status of data and analytical tools. In Portland, the accessibility measures are derived from model data that include non-work trips. This is possible because of the capabilities of Metro's analytical tools that are not widely prevalent in other MPOs. In many other regions, the ability to generate measures of mobility and accessibility is limited to the work-related trips, particularly when considering trips made by any mode other than the auto. Some planners argue that, given the growing percentage of daily person trips that are not work related, accessibility measures need to consider access to opportunities other than just employment, such as services, shopping, and recreation. Because of the different trip-making characteristics of different income level groups (number of trips, purpose, and mode) there are social equity issues implicit in measures of accessibility and mobility. It will be a challenge for most regions to develop the level of analytical capabilities needed to populate the performance measures in a way that addresses the equity aspects of mobility and accessibility.

Twin Cities

The Minnesota State Legislature required the Metropolitan Council to perform an audit of the region's transportation system. The purpose of the audit was to look at the transportation system as a "system" instead of agency-defined modes and services. In addition, the audit was intended to provide public accountability for the amount of resources that were being allocated to the system. A review of recently completed policy statements and plans provided an overview of the regional goals and objectives guiding transportation investment. From these goals and objectives, several major themes became apparent including such things as ensuring economic growth and competitiveness, encouraging growth management, preserving the condition and integrity of the existing infrastructure and minimizing the impacts on the environment.

The evaluation framework for the audit focused on three levels, starting first with transportation system performance, then leading to economic growth and competitiveness, then leading to quality of life. For audit purposes, performance measurement had to be related to some datum such as a benchmark, peer comparison, or performance standard. Each of these categories of assessment were used in the audit. Included in this assessment were the results of transportation system customer satisfaction both from households and businesses.

Lessons Learned from the Twin Cities

The Twin Cities case study reflects a growing use of performance-based planning – providing accountability for public resources expended. The concept of an audit targets the relationship between these expenditures and system performance. Of great interest in the Twin Cities case was the broadening of the outcome measures to include economic growth/competitiveness and quality of life. The performance measures thus became directly linked to stated regional goals and objectives. Also, the emphasis on customer input into an assessment of performance satisfaction recognizes the need for including the ultimate user of the transportation system into the performance monitoring process. The specific lessons learned from the Twin Cities case include:

- The broadening of performance outcomes to include topics such as economic growth and quality of life is meaningful when the linkage to transportation system performance is made clear.

- Performance measurement over time is meaningful when related to changes that occur and that reflect some datum of reference. This datum can simply be the change from the last measurement cycle, peer comparison, use of performance standards, or benchmarks.

- Customer orientation is an important element of measuring system performance. Not only does this relate to the original definition of appropriate measures, but also to the actual determination of system performance relative to customer expectations.

2.2 State-Level Examples

Although several states have been involved with program performance measurement for years, the first mandate for performance-based planning occurred with the ISTEA-required management systems. These management systems were supposed to monitor system performance (as defined through performance measures) and provide this information to decision-makers. Even though the development and use of management systems has been made voluntary, many states have continued with their development. These experiences provide the basis for two of the case studies that focused on state-level planning.

Florida DOT

The Florida DOT has one of the longest histories with performance-based planning of any state DOT in the country. This is partly due to a focus in state government on increased accountability in the use of state dollars. The Florida Transportation Plan explicitly states that performance measures will be used in revising goals and objectives, and that indicators of progress will be used to measure progress toward long-range objectives. The Short-Range Component of the Plan is the basis for an annual performance report on the level of achievement of the 15 short-range objectives. In this case, key indicators are used to measure this achievement. In addition to these planning measures, much of the early work on measuring performance related to program productivity and the monitoring of agency output. The DOT has been very careful in defining a set of budget program measures that reflect agency actions. These measures are designed to link the expenditure of state dollars to program performance.

The Florida DOT was one of the first DOTs to develop a comprehensive intermodal management system (IMS), partly with support from a grant from the U.S. DOT. The original concept of the IMS was for the focus to be systemwide with emphasis given to the characteristics of flow within transfer facilities as well as quality of access to and from the facilities. As this effort evolved, the focus became a facility by facility review of the access characteristics to the state's highway network, with capacity and utilization of the facility being dropped from consideration. This new focus further evolved into a process whereby points were assigned to empirical observations that could be used to establish priorities for specific improvements. These priorities were to be established by the DOT district offices that were responsible for establishing capital programs.

Thus, instead of the original purpose of revealing system conditions to program managers, the new purpose of the IMS was to establish the comparative need among projects in the development of a capital program. After a two-year test period, an internal evaluation of the IMS concluded that no district had used the information for establishing priorities. However, there still seemed to be support for having an IMS in place that monitors a portion of the system that did not traditionally receive much attention.

Lessons Learned From Florida

Because Florida was one of the first states to use performance-based planning concepts in program operation, the observations from this case study provide useful insights on the evolution of such concepts. A key conclusion of this case study is that participants very carefully *distinguish between performance measures and indicators of conditions*. Indicators provide information on what is happening to system characteristics that are deemed critical to program operation, but they do not necessarily relate directly to a causal linkage with agency action. Thus, performance measures per se become triggering devices which indicate when further study is warranted. They may not by themselves serve as good diagnostic measures.

The ability to track key characteristics of the system, even though the Florida DOT may not have direct control over the outcome, becomes a critical component of the agency's commitment to improve its actual performance. Florida DOT officials caution that performance measures could oversimplify the phenomena that cause the outcomes being observed. The existence of a monitoring program that provides feedback to agency managers allows a certain amount of flexibility in responding to "problems."

Another interesting observation from the Florida case study is the distinction being made between outputs and outcomes. There are several external pressures on the DOT to use output measures that provide some sense of program accountability. However, there is growing pressure from some constituencies to develop outcome measures that relate transportation system performance to quality of life issues and economic development. Although DOT officials recognize the importance of such measures, they are hesitant to adopt a process that establishes accountability for measures over which they have little influence.

Other specific observations that come from the Florida case study include:

- Establishing causality between program investment and performance measures becomes a critically important technical and political issue.

- The *process* of monitoring system performance was considered as important, if not more so, than the actual performance measures.

- The evolution of Florida DOT's performance-based planning process into a prioritization scheme was unsuccessful. This was partly true because of the tendency to have the prioritization approach remain dominated by negotiation and bargaining.

- An important role for performance measures is as triggering devices for more detailed study and diagnoses. This is one way of integrating performance measures more closely with existing planning procedures.

- A concern was expressed about the danger of decision-makers "chasing" the performance measures. By this is meant that once it is known how "success" will be measured, basic human nature suggests that those projects which most quickly and easily achieve this success will be selected. This might occur even though the root cause of the problem being solved might demand different solutions.

Oregon DOT

Along with Florida, Oregon was one of the earliest states to devote considerable resources to the development of a statewide intermodal management system (IMS). Similar to the experience in Florida, the Oregon IMS evolved from a global and comprehensive set of possible performance measures to a smaller and more focused set of working measures. The early phase of IMS development included the undertaking of an inventory of intermodal facilities, the definition of a set of general measures of performance, and the identification of the corresponding data requirements. Once the sheer scale of such an IMS became known, the IMS concept was refocused onto one concept – the quality of access into and out of major points of transfer.

This new focus of the IMS was developed based on extensive input from transportation system stakeholders who identified five critical dimensions of performance measures –

capacity, accessibility, connectivity, time delay and safety. Attention was given to establishing thresholds of acceptable performance and to using this information for prioritizing projects. Currently, the relationship between revealing needs (which one would argue is a purview of management systems) and the establishment of priorities is being debated. Of great concern is a perception that performance measures would supplant the decision process of establishing priorities.

Lessons Learned from Oregon

The evolution of the IMS in Oregon is strikingly similar to that found in Florida. The move away from a global management system to a focus on those elements of the transportation system under the control of the public agency, i.e., access links, was true in both cases. The trend toward using performance-based planning as a means of prioritizing projects, only to run into reluctance, was found in both. Specific observations that come from the Oregon case include:

- Performance measures were refined to reflect only those elements of the transportation system under control of the agency.

- Efforts to supplant (or at least perceptions of such efforts) the political process associated with prioritization were not well received.

- The Oregon IMS generally turned out to have a dual focus on freight-only movement and intermodal movements. This dual focus was considered by some as a useful addition to the planning process because of previous neglect of this sector, but was lamented by others due to the loss of a total "systems" perspective. This illustrates the important roles that such a planning approach can play.

- Over 1,000 stakeholders participated in the development of the IMS. This extensive involvement was generally considered to be a key to the successful definition of an IMS that would have an important role in the transportation planning process.

- There was great hesitation in further refining performance measures to ever finer quantification. The measures were viewed as input into planning, not as replacing the planning process itself. Thus, high levels of disaggregation were not necessary.

Washington State DOT

The Washington State DOT along with key regional partners undertook the Eastern Washington Intermodal Transportation Study whose intent was to study the mobility needs of agricultural commodities. By developing a logistics chain database for important commodities, transportation officials can then understand the implications of alternative policies. The important difference in this study from others similar is that the focus was on the "trip" of a commodity from origin to destination, rather than on aggregate flows across a transportation network. So, for example, the study examined the timing of harvests, the demands for transportation, and the resulting impacts on the network.

It is interesting to note that although the perspective adopted in this study was very much oriented toward users of the transportation system, the performance measures were targeted at those system components under the control of the state DOT. As in Florida, Washington State is using the concept of indicators to represent phenomena that are not causally linked to agency action. And even where user-based measures can be identified, they need to be aggregated into an overall system measure given that the user is just one of many that utilize the transportation system.

A similar effort to the Eastern Washington study has been occurring in Seattle. The Puget Sound Regional Council (PSRC) has developed an analysis process for freight planning that is commodity-based, rather than the traditional reliance on land use characteristics. The PSRC has developed a monitoring program consisting of 26 critical segments of the region's road network, mainly measuring conditions experienced by trucks. Many of these segments are strategic locations between ports and major warehouses. Five major categories of performance measures have been identified for these segments – reliability, access, time and congestion, costs/benefits, and safety. At this point, these measures are to be used to report trends, but are viewed as the basis for a more systematic planning process aimed at freight movement in the region.

Lessons Learned from Washington State

This case study focused on system performance as it related to freight movement. Experience with similar types of studies showed that when freight stakeholders are brought into the process, the resulting performance-based planning effort becomes quite meaningful. However, a freight focus also raises the question of how user-specific transportation issues that are important to a specific group can be generalized to the entire system. The specific observations that result from this case study include:

- Both system-based and user-based performance measures should be included in performance-based planning.

- The level of disaggregation of performance measures will be related directly to the type of information desired. Thus, for example whether user-based, commodity-based, or market group-based measures are defined depends ultimately on the types of decisions likely to be made based on this information.

- A market group focus for performance measures draws a strong linkage between economic productivity and the performance of the transportation system. This is one way of defining a performance measure that focuses on the "outcome" of economic productivity.

- As in other cases, the Washington State case shows the concern with having performance measures replace decision-making in establishing priorities. Such prioritization is considered the purview of the political process and should remain so. As noted by one participant, "the kinds of information needed will be revealed by actual political decisions you want to make."

Vermont Agency of Transportation

The Vermont Agency of Transportation (AOT) has set in motion a program to monitor the performance of the programs aimed at improving the quality of transportation in the state. The program is based on both the commitment of the agency, and legislative mandate to undertake a program of monitoring and feedback in the planning process. The agency undertook a massive customer survey as part of the long-range planning effort in 1994, and is working on methods to continue meaningful communication with the customers of the agency.

Senior managers at the agency reported satisfaction with the development of a program to monitor the outputs of the agency's work, but are now wrestling with the transition to the use of outcomes. Managers feel that certain departments have made major strides in the reorientation of their work towards a program of performance-based evaluation. For example, high-level managers believe that the pavement program has evolved away from a list of projects, conceived as separate projects, to a system which can be described, evaluated and understood. This is described as a significant improvement over previous conditions, and a big step towards application of performance evaluation to strategic planning and management.

The biggest challenge of the managers at this time is the development of a meaningful program of monitoring in the maintenance department. As part of the process, the maintenance department is designing a new telephone log system to capture customer requests, a mechanism to annual survey district customers, and a numerical index to rate maintenance conditions for road sections. These examples show how the agency has augmented or modified their data collection and manipulation systems to better suit the information demands of the performance-based approach.

2.3 Service Providers

One of the traditional uses of performance measurement has been in those industries providing a service to customers who often have other options. Thus, knowing the key attributes of the service that are important to the customers and monitoring these system characteristics become critical elements of successful management. The following **three** cases illustrate performance-based planning concepts as they have been applied in passenger and freight transportation operations.

Amtrak

As part of its strategy to attract customers, Amtrak management instituted a Customer Satisfaction Tracking System (CSTS) as input into operations and capital decisions. In 1994, Amtrak sponsored a survey of more than 10,000 customers to determine the most important factors for customer satisfaction. After these factors were identified (13 ranging from schedule adherence to bathroom odor), customers on each of Amtrak's product lines were surveyed in a regular basis. A three-month rolling average was used to track customer satisfaction trends. A composite Customer Satisfaction Index (CSI) was developed which became the major indicator of customer satisfaction as reported to the Board of Directors. Because this index is presented to the Board, it becomes an important measure in the organization when investment decisions are being made.

There is some evidence to suggest that several managers are using the entire database to make decisions at their level as well. For example, customer dissatisfaction with the provision of information during train delays caused a manager to direct train operators to provide more frequent time information to passengers. Another manager has developed a regression model based on the raw data to isolate the most important characteristics that are used to prioritize service changes.

Lessons Learned from Amtrak

The understanding of customer satisfaction with the service being provided and the use of this information in decision-making is a good example of the use of performance measurement. The importance of the CSTS to Amtrak's customer-driven management system is widely accepted by agency managers. However, several managers question the usefulness of a performance-based day-to-day management planning tool that was primarily oriented to the Board of Directors. In order to motivate agency personnel and influence operations with customer satisfaction measures, there needs to be a "buy-in" from managers and employees. One way of doing this was repeatedly suggested by those interviewed – include managers in the process of developing relevant tools. Specific observations that come from the Amtrak case study include:

- Performance-based planning can provide important management decision support for those organizations providing customer service.
- Customer-oriented product delivery requires a good understanding of the desired service characteristics and of the status of those characteristics in actual service delivery.
- Surveys can be important means of gauging customer satisfaction especially when administered on a periodic basis. Surveys are most relevant to performance-based planning when they focus on those characteristics deemed most important to the customer.
- Including those officials who will be the ultimate users of performance-based planning in the process of defining key parameters is critical to successful implementation.

Miami Valley Regional Transit Authority (Dayton, OH)

In the early 1990s, the Miami Valley Regional Transit Authority found itself in an ever worsening situation of being isolated from the community it was meant to serve. New agency leadership in 1991 decided that credibility with the community was the most crucial issue facing the Authority, and thus embarked upon a process of establishing this credibility. A committee was established of civic, business, and constituency leaders with a mandate to develop a strategic direction for the agency. As part of this strategic direction, the Authority instituted a service standards process whereby service performance could be monitored and new service requests could be evaluated in terms understandable to the community. Four service standards were defined by the Authority: passengers per platform hour, vehicle load factors, on-time performance, and community-based service needs. The last standard is a qualitative assessment of how a service relates to fundamental community needs such as access to key employment, commercial or medical facilities. A wide-ranging data collection effort supports the monitoring of system performance.

In addition to the use of performance measures, organizational changes have occurred which further implement the system performance orientation of the Authority. The planning staff has been given responsibility for scheduling and is expected to field customer complaints twice per month. This provides a direct linkage between customer perceptions on service provision and actual provision of service. Future plans include the development of a core set of benchmarked performance measures that will become part of the service standards process. Customer-based, quality-focused performance measures will supplement operating statistics for Board use and community outreach. Baseline surveys will be conducted in 1998 to identify key parameters in customer-perceived quality of service provision, important issues associated with transit, and relative levels of importance attached to each.

Lessons Learned from Dayton

Specific observations that come from the Miami Valley Regional transit Authority case study include:

- The implementation of performance-based planning is an evolutionary process with important “developmental” phases along the way. In this case, community involvement and public perception that there is a vested interest in enhancing system performance was critical.

- Credibility in the process means that periodic system measurement provides a sense that customers and stakeholders are receiving benefits for their investment.

- Credibility in the process also means having the resources to deal with the problems that surface from the performance-based planning process. The Authority’s gain in community acceptance can be related to the attention being paid to deferred issues.

United Parcel Service

United Parcel Service (UPS) is the largest parcel delivery company in the world and one of the largest express and overnight shippers. Today, UPS is an integrated information delivery company offering a range of expedited, standard ground, logistics support and information dissemination services across the world.

UPS’ measurement systems have traditionally focused on productivity, efficiency, and finance. An unofficial company philosophy was that there was a most efficient way to do everything. Efficiency concerns were a factor in a consistent pattern of goals and objectives oriented to revenue and volume growth. Early performance measures in support of these goals included volume growth, revenue growth, time-in-transit and cost per package. Profit concerns were not as explicitly assessed in UPS' early systems. In recent years, profit has become a more explicit concern with realization that revenue and volume growth does not necessarily equate to profit growth.

Within the last five to 15 years, UPS managers have concluded that an exclusive focus on efficiency and finances, particularly volume growth, was creating long-term negative implications especially for fixed asset requirements. This conclusion was based in part on external factors such as industry deregulation and the rapid expansion of competition. For example, new service offerings brought about by competition could not be assessed (and serviced) in same way as traditional ground service. Also, with market forces providing greater leverage to the customer, old actions based on internal productivity concerns (such as package drop-off/pick-up at same time) could not be maintained.

All in all, many forces have come together to compel UPS to take a broader approach to performance measurement. However, the current approach did not develop from a clean adaptation of prior systems. There were many false starts and changes in plans. As recently as five years ago, the system was considered by some managers to be unwieldy, with 25 measures in use at top levels.

UPS' case study participants stated that a performance measurement should be applied in both top-bottom and bottom-up fashions. However, the system should be established solely top-down, with key corporate goals, rather than data availability, used as the driver and alignment mechanism for all measures. With the wealth of data and information available to management, there is a constant need at UPS to identify the most important decision-making needs at each level and focus on that information. Since most upper management at UPS started at lower levels and were promoted from within, they tended to develop an affinity for information availability at lower levels. Many individuals struggle with temptation to gather and review detailed information since it is readily available.

Given the concerns UPS has experienced with data ownership, the transportation planning field may want to begin exploring the issue. With the potential to automatically collect data using ITS, instrumented vehicles or advanced surveying techniques, planning information may become readily available from many different sources. Groups other than planners and traffic engineers could begin to be sources of valuable information for transportation planning.

Lessons Learned from UPS

While UPS is different from most transportation planning agencies in fundamental ways, there are useful observations to be made.

- UPS has invested heavily in information systems over the last 10 years. They have underestimated the cost of maintaining this new infrastructure, and also did not fully anticipate the additional costs that are incurred just by virtue of having data available (e.g., customers now wanting information over the internet). An aggressive investment in IT and data collection undoubtedly creates a need for even more investment.

- The emphasis remains on providing the least amount of information that is needed to make an informed decision. The timeliness of information is more critical than quantity of information at all levels, particularly when there is a need to isolate the effect of new initiatives.

- UPS rapidly changes and adapts its management strategies and measurement systems based on decision-making needs and market forces. This willingness to change approaches is somewhat reflective of the flexibility and needs provided by a private sector environment. Yet the potential lesson for transportation planning agencies should not be overlooked; undue concerns about the long-term stability of measurement systems and specific measures may paralyze agencies and prevent them from responding to changing internal and external forces.

- Explicit linking of diagnostic indicators and strategic performance measures allows front-line managers to identify, evaluate and select actions with an eye to strategic objectives. That is, different kinds of measures may be needed to track performance with respect to strategic objectives, as opposed to measures that are better diagnostics of the problems and effective solutions.

- Performance measures become more useful when users understand what drives performance. UPS is using feedback and evaluation, particularly in terms of customer satisfaction, to help identify effective performance drivers.

- While financial measure are still important in the private sector, some companies such as UPS are trying to measure, interpret and predict financial performance in a broader context that incorporates customer- and employee-oriented measures

- Even in an environment where data collection is not a constraint, the selection, evaluation and interpretation of performance information is not simple. The availability of "unlimited" information creates new problems of putting it all together, or of "creating information out of data."

3.0 Workshops

An important component of the Phase II research plan was the organization of several workshops to present incremental results to groups of interested potential end-users of the products. The primary purpose of these workshops was to solicit comments and suggestions on the proposed research plan and findings, and use the information to refine the research plan or methods if appropriate and guide development of the final products so as to improve their overall usefulness.

Four such workshops were held during Phase II (in addition to the four held during Phase I) over the period July 1997 to January 1998. The workshops were held in conjunction with the summer meeting of the TRB Committee on Statewide Multimodal Planning; the ITE Annual Meeting; the Association of Metropolitan Planning Organizations Annual Meeting, and the TRB Annual Meeting. These different meetings were used as organizing venues in order to attract participants representing a wide range of organizations and perspectives.

■ 3.1 Summary of Findings

The more detailed notes from each of the four workshops are included below. The following general observations can be made:

- Despite the lack of published information about this research project in particular and performance-based planning in general, there is widespread interest in both. More and more agencies are becoming aware of the application of performance measures to the planning process, and as they do so, the demand for information and guidance is growing. Although a number of transportation planning agencies have invested in the process, application of performance-based methods to the transportation planning process is still very much in a growth and discovery mode.

- There continues to be a healthy debate over the intended application of performance measures. State and local agencies are concerned that there is an agenda to use performance measures to score and rank agencies according to organizational performance criteria, perhaps using externally-determined criteria. The many representatives we have met from state DOTs, MPOs, transit agencies, and local government are relatively uniform in their desire to focus on measures of system performance rather than organizational performance. This does not ignore the fact that there is a related movement afoot in many public agencies to develop systems for measuring organizational performance and efficiency. Much of the impetus for this organizational performance measurement comes from legislative bodies interested in monitoring the cost-effectiveness of transportation agencies. But there is an audience for guidance and information sharing on performance-based planning methods that focuses on system performance and outcome of different investment strategies, apart from the organizational issues.

- The perspective of what is important does indeed vary across many dimensions: state versus MPO, urban versus rural, passenger versus freight, etc. This raises the question of how to provide guidance that is both specific enough to be useful to those who already are using a performance-based approach and at the same time broad and flexible enough to be valid across such a range of perspectives. For example, it is generally true that state DOTs are relatively more preoccupied with system maintenance and preservation, while MPOs find themselves dealing with less quantifiable issues such as community values, sustainability, etc. The more urban agencies tend of course to be quite interested in developing mode-neutral measures of system performance and outcome, often so as to minimize a perceived historical bias towards highway investments. Less urbanized states with large highway miles may have a more traditional perspective, or at least may have a dramatic range of perspectives from the urban districts to the rural ones.

- Agencies are concerned about their ability to effect improvement in an area of measurement. For example, safety is a key area of measurement for most DOTs and many other agencies as well. Yet, the overall outcome of safety, whether just the highway system or the entire surface transportation system, is the result of many factors, a number of them external to, and beyond the immediate control of, the agency doing the monitoring. Mobility, another primary area of interest for most DOTs and MPOs, is also impacted by external trends in in-migration, job formation, transportation costs, etc. Usually there are numerous agencies that contribute to overall mobility of an urban area or state. Agencies are concerned that while they may track numerous mobility-related measures, their positive achievements may be dwarfed by external factors resulting from trends or decisions made outside of their purview.

- There has been a very noticeable shift to practices which favor incorporation of the "customer" or user perspective in defining and evaluating performance of an agency. Attitudinal surveys, focus groups, and other methods have been employed to establish who the customer base really is, what segments it is made of, what is important to these customer market segments, and what constitute realistic expectations on the part of the customer. At the same time, agencies realize that there is a need for balance of perspective here. There are entire elements of the agency's operation that are critical to the overall mission but practically invisible to the customer, such as certain system preservation and maintenance functions.

The following summaries present additional discussion and conclusions from the four workshops.

■ 3.2 Montana (TRB Multimodal Planning Committee Summer Meeting)

The first NCHRP 8-32(2) workshop of this phase of the project was held on July 28, 1997, in Essex, Montana in conjunction with the TRB Statewide Multimodal Planning Committee summer meeting. This workshop was attended by about 25 members, including representatives of several state DOTs, FHWA/FTA staff, and a small number of other members including consultants. The workshop included the following segments:

- Overview of the workshop purpose and format;
- Summary of the purpose and findings to date of 8-32(2);
- Summary of Phase II objectives and work plan; and
- Discussion of several aspects of performance-based planning, including:
  - Barriers to implementing performance-based planning
  - Customer satisfaction and perception
  - Performance measures
  - Data-related issues
  - Federal/state and state/local issues
  - Proposed TRB Subcommittee on Performance Measures

Major Questions and Comments Raised During the Workshop

Comments Regarding the Phase II Research Plan

Several DOT members commented that the workshops should include the perspective of elected decision-makers and legislative representatives. These members felt that the proposed workshops were focused on groups that exclusively represent "technical" agency staff, and that to be effective, the proposed methods need to be acceptable to groups such as MPO boards, transportation commissioners, etc. Suggested venues included the National Governors Association and the Conference of Legislators. A follow-up suggestion was made that the technical advisory committees to MPOs and transit agencies should be consulted during the workshop process. As a result of this suggestion, a workshop was added at the September 1997 Association of Metropolitan Planning Organizations conference.

The TRB Committee Chair and workshop host Neil Pederson asked whether the research project would focus on performance measurement in the context of programming or planning. We responded that although our research has looked at application of performance measurement to a variety of functions including planning, programming, budgeting, internal management, etc., the focus of this project is in the area of planning, and our products will be oriented primarily to that function.

Participants questioned whether the proposed selection of case study sites was skewed towards growth-management states, and whether that might limit the usefulness of findings for other states. Two committee members representing growth-management states replied that in their experience, the linkage between application of performance measurement methodologies and growth management was not a critical factor. We also noted that if in our research we identified instances where the presence of strong growth management controls was necessary to support certain performance-based approaches, we would make that clear. We also pointed out that in Phase II we had intentionally selected states and MPOs with some track record in performance measurement, and that there may be some correlation between states with more aggressive land use/transportation planning linkages and performance-based planning and programming. The research team was asked to be aware of this potential linkage, particularly in the Washington, Oregon, Florida, and Portland Metro case studies.

Barriers to Implementation

In the discussion about the barriers that may exist to the implementation of performance measurement and performance-based planning concepts, the following questions and comments were made:

- **Term Limits***:* The trend in some states towards legislative term limits was raised as a potential obstacle. A frequent change in policy makers leads to more frequent change of objectives, creating the potential need to change the system performance measurement too often. The group consensus was that it is probably too early to tell whether legislative term limits themselves represent a significant barrier. Some members felt that the opposite may be true, that is, with a shorter legislative "memory", lawmakers and commissioners might find it necessary to rely more heavily on a consistent system of performance measurement. With a limited term, legislators might be more inclined to use the system they inherit upon taking office rather than try to reinvent it. There might be periodic efforts to change the standards or targets to be achieved, rather than the measures or areas of measurement themselves. Committee members commented that in fact a good system of performance measurement might help mitigate or dampen some of the agenda "swings" they might otherwise expect to result from term limits.

- **Lack of Clear Objectives***:* Lack of a clear objective was cited several by members as a significant barrier to successful implementation. An agency needs to more clearly articulate *what* they are trying to accomplish by adopting a system of performance measurement, reporting, and monitoring. Comments suggested that it is still the case that agencies focus too quickly on *how* to use performance measures without clearly articulating what their objectives are, and gaining buy-in to that view. We asked whether the goal and objective statements from long- and short-range system plans were a good enough source from which to draw performance measures and standards. Members replied that plans often need to be more explicit and the linkage to performance measures more evident than is typically the case.

- **Resource Limitations***:* Some of those present questioned whether simple resource issues might keep performance-based planning from being more broadly adopted, and suggested that the efforts may suffer the same fate as the ISTEA Management Systems. Others felt strongly that there are significant differences between independent performance-based planning efforts and the federally-mandated Management Systems. They noted that not all states *will* undertake comprehensive performance measurement efforts, but that many states will be able to draw guidance from the examples.

Other potential barriers to successful implementation suggested include:

- Unwillingness to put "bad news" on the table; those with experience suggested it is important to report accurately and objectively, even the bad news.
- Propensity to measure elements that are "flashy" but not critical to the agency's mission.
- Unwillingness to measure performance of a system that the agency cannot directly or completely influence.

Federal/State and State/Local Relationships

A unique aspect of this workshop, given the host Committee, was the perspective on how performance measurement may be used at one level of jurisdiction to evaluate the performance at another level. While the tension between state DOTs and the U.S. DOT on this particular issue is well acknowledged, we encouraged the members present to also consider whether there was a similar tension or conflict between their state agencies and regional or local transportation agencies.

Agency Comparisons: Members commented that where they have used performance measures to grade and compare, they have encountered resistance; where they have attempted instead to guide resource distribution, they have found less opposition. To the extent that the states ask locals to spend local dollars for data collection, however, they do encounter resistance.

Partnerships: Another state/local issue occurs where the state has an interest in routes of significance that are not on the state system (intermodal connectors such as port access roads being a good example.) In these cases, performance measurement can be used to establish the level of need and to encourage the development of partnerships (interjurisdictional as well as public-private) to address the need.

Performance Measures as a Funding Mechanism. Both at the state and local level there is concern about the possibility that performance measures may be used to directly determine funding allocation. There is an obvious potential problem if declining performance or condition results in reduced resources to an agency or program, as this tends to create a self-eroding or downward-spiraling situation. Transit operators may demand a "hold harmless" clause for funding based on performance, or a minimum funding floor. Intrastate and trunk highway systems may be adversely affected if the state sets policy without adequate regard to local needs. It is important in these cases to seek state/local agreement on specific objectives before these are translated into performance measures or standards.

Performance Measures

Part of the discussion focused on the performance measures themselves, and there is obviously a great level of interest in the nuts and bolts of the process. While many of the issues raised have been raised before, they are worth noting and repeating:

- **Simplicity**. In a planning application in particular, measures need to be readily understood by decision-makers and the lay public. This supports the concept of a hierarchy of measures, with the top-most levels being the most aggregate, composite system performance and condition indicators that provide decision-makers and the public with a summary of results (or predicted results.)

- **Structured Hierarchy of Measures**. A hierarchy of measures can be effective in allowing agencies – and their stakeholders or customers – to monitor both internal performance efficiency and external outcome. But it is easy to get consumed in the pursuit of the performance measures themselves, which is why some higher-level, strategic reporting is desirable, in addition to what may be useful at the program or project level.

- **Control over Outcome**. It is useful to identify *who* (i.e., which agencies or other parties) actually influence outcome on a particular measure. It is rarely the case that any one unit or agency controls the outcome in some broad area of measurement. The best example given of this was in the area of safety, where the state DOT tracks performance but actually controls only a limited number of factors. Contributing factors other than roadway design and condition, such as driver skill and condition, vehicles, etc., are often the domain of other agencies. The fact that the monitoring agency does not fully control the outcome *does not* suggest that they should not monitor that element, but rather, ensure that the system of measures is specific enough to provide some diagnostic capabilities. If the major underlying causes of accidents can be tracked with the system, for example, the agency is in a better position to define strategies involving other partners who also control the inputs (e.g., driver training, enforcement, etc.) and thus the outcome.

- **Transportation's Real Contribution to Outcome**. This recognition that control over outcome is usually complex and multi-jurisdictional may be useful in dispelling some notions about what transportation's real role and contribution to outcomes. This is particularly true the more broadly we define our areas of measurement. For example, identifying transportation's actual contribution to overall changes in the environment (e.g., air quality or stream habitat) is more problematic than in a more focused area such as safety or mobility. Recognizing this, it appears that several agencies that have been using performance measures for several years have attempted to define a more concise universe of measurement areas, and to focus more specifically on their system's contributions to outcome rather than on the total outcome.

- **Output versus Outcome Measures**. Since the completion of Phase I of this study, there has been more widespread discussion of the concept of "output" and "outcome" measures. The group consensus seems to be that:

  – Outcome measures have been historically under-represented in the typical DOT measurement and evaluation processes.

  – Extra effort needs to be made (as it has in certain states and MPOs) to develop a better sense of the customer and external stakeholder perceptions of performance and importance, and to represent these perceptions in the measurement system.

  – That notwithstanding, there is a need for balance between the two types of measures, not a wholesale replacement of useful output measures which have an important part in informing management and planning decisions.

- **Proxy Measures**. The notion of surrogate or proxy measures has been introduced through this research effort and other projects as well. This is in response to the data and analytical methods resource concerns. The idea is that while a plan goal or objective might suggest an ideal measure, real limitations on data collection and analysis may suggest or require that a less ideal measure be adopted in the interim, based upon more readily available data resources. In time, data collection and analytical capabilities (e.g., travel time information available through ITS deployment) will make the ideal measure more feasible.

Customer Perception and Satisfaction

A final area of discussion at the Montana workshop centered on the value of incorporating the system users' (or "customers") perception of performance into any evaluation scheme. Some states such as Minnesota have taken this concept to new levels, and have greatly improved the state of the practice in determining what is important to the customer and how to use the information. The following guidance and opinions should be useful to other states and MPOs who want to incorporate the customer perspective:

- Take care to define who your customers are; some states include "internal stakeholders" as customers, others focus on the system users. It is important to include *anyone* with mobility needs, not just current users of the system, and this presents some challenges in terms of identifying and reaching out to these latent non-users.

- Define what is *important* to your customers, as well as what they expect in the way of performance relative to what the system currently provides.

- One agency which has employed market research specialists to assist in surveying customer perception advises "Don't ask questions unless you are willing to deal with the answer," or perhaps more completely, don't survey customers about aspects of system condition or performance that the agency does not intend to address through their investment programs.

- While the 8-32(2) products will not go into the details of survey methodology, a summary of general points and practices to be observed would be useful. The appropriate use of focus groups, for example, was described by some as to help with issue identification, survey design, and pretesting. But such focus groups, especially hand-selected "expert" focus groups as opposed to more randomly selected groups, might not be the best way to assess customer perception.

- Some members expressed the opinion that agencies should not rely too extensively on customer perception; their perspective may reflect too-short a timeframe, or may ignore the important longer-term maintenance and preservation functions of a DOT. Some of the preservation-oriented activities are not perceptible to the user, but are nonetheless critical to the agency's mission. In many states, the focus is shifting from modernization to maintenance and preservation, suggesting that operational and maintenance issues are more critical to the agency than some of the more visible, customer-oriented outcome measures. This suggests again the need for a balance of perspectives, rather than a radical swing to an outcome-based, customer-dominant perspective.

- Perhaps surprisingly, more than one DOT representative noted that customers, while more knowledgeable and demanding than in the past, are also somewhat more realistic than the system planners. They may have a more constrained view of what can actually be changed or improved.

Summary

The Montana workshop, involving predominantly state DOT and FHWA/FTA representatives, was extremely useful in helping to focus in on areas of interest to the ultimate audience for the Performance-Based Planning Manual. Although not all of the suggestions can be accommodated in the research plan, there were many observations and examples that have helped to shape the end product and make it more useful.

3.3 Boston (ITE International Meeting)

The study team conducted the second workshop at the ITE International Meeting in Boston on August 4, 1997. Led by Peter Zabierek and Matthew Coogan, the study team met with a group of about a dozen practitioners. About half the group were consultants, while the remainder included MPO staff, one state DOT representative, and two university researchers.

The two-hour session began with an introduction of participants and an identification of what each participant wanted from the meeting. In general, the group agreed that their intentions were to share experiences in performance-based planning, identify and apply concepts, and identify additional resources. There were some focused requests for applying concepts in both the long-range planning and the MIS processes.

Defining Performance-Based Planning

The consultant team opened by leading the group in a discussion of the definition of performance-based planning. In order to give the group something to react to, the following candidate definition was presented:

> *Performance-based planning is the planning for system and facility improvements that lead to enhanced performance of the transportation system where desired system performance is explicitly stated at the outset and monitored over time.*

While the group found the exercise useful for orientation purposes, they had a number of criticisms, constructive and otherwise, of the definition. Among them:

- "'Enhanced performance?' Given the development and growth pressures we are dealing with, we'd be lucky to keep the status quo. We should replace the word 'enhanced' with something like 'the best possible.'"

- "This definition brings up more questions than it answers. What do we mean by 'performance of the transportation system?' Do we mean from a total trip perspective, individual modes, or what?"

- "Does performance-based planning include monitoring? If so, they should include it in the title."

- "I like the fact that it includes monitoring. Otherwise, what's the use?"

Dimensions of Performance

While most of the participants each had a wide variety of interests and experiences, this discussion focused on only the "application" dimensions of performance, i.e., how to apply the process to various planning processes (e.g., MIS, long-range plan).

One participant cautioned the group to be careful when using customer surveys to generate performance information at a corridor level. Oftentimes, in his experience, customer surveys are distributed only to those who live in that particular corridor, and do not consider others who use the corridor. This can lead to suboptimal solutions, he said, as system-level improvements like ramp metering may be eschewed because of their negative local impacts. In addition, while he touted the value of the public participation process, he expressed concern that customer satisfaction performance measures could drive project selection process, and rigorous technical analysis would be ignored.

A number of participants echoed words of caution on the use of customer surveys. One participant claimed that "…many of the surveys we do for transportation assume that the customer is homogenous. Of course, that's not true. Take the elderly, for example. They do not work 9:00 a.m. to 5:00 p.m. jobs, they have a greater need for social services, and their modal options are usually few. If we're going to use customer information, let's appreciate the nuances of the market."

The topic closed with discussion of how to develop performance measures for an MIS, and how that may be different than those used for a subarea. In general, the group agreed that the process starts with an identification of goals and objectives for the corridor, and continues with linking the performance measures to these goals and objectives. The group expressed a desire to move away from the ordinary LOS measure to broader definitions of system performance. Door-to-door travel times, VMT/person trip, and person-throughput measures were all discussed as possible options.

Current Issues in Performance-Based Planning

As had been discussed in other workshops, the group opened a discussion of the most topical issues in performance-based planning. These issues were summarized as:

- Barriers to implementation;
- Customer satisfaction;

- Developing/selecting performance measures;
- Data; and
- Federal-state, state-local relationships.

While the participants agreed that all of these issues were important, the majority claimed that the data issues and the difficult process of selecting the "right" performance measures were their highest priority at the time.

As for the data issues, the study team provided some information from Phase I of the 8-32(2) project, which provided some resources for the efficient collection, storage, and dissemination of data. Many of these strategies included ITS technologies. In addition, some participants suggested other data sources that may not always get tapped, such as Census data, HERS and HPMS data, safety information submitted to state and police departments, and National Transit Database data. One participant from the Texas Transportation Institute described their work on the "congestion index," how that data was collected and how it can be used to benchmark one metropolitan area versus another.

Developing performance measures, the other top concern amongst the group, began with a reminder of the "K.I.S.S" principle ("Keep it simple…). One of the ITS-savvy participants made an analogy to the "few good measures" principle used in the ITS community. "Given that there will be only a few, how can you measure transportation's contribution to broad outcomes?" asked one participant. One reply was that one needs to develop performance measures that answer a number of different questions. Another was "you'll never be able to capture everything, so do the best you can with a few measures." Finally, the project team shared the Albany, NY MPO experience, where the agency defined both "core" measures, which are used at a high decision-making level and secondary measures which are used by technical staff.

Summary of Findings

- Developing a definition of performance-based planning is difficult yet instructive. While not absolutely necessary, an agency might find value in developing its own working definition of the concept so that stakeholders understand the scope of the process.

- Use care when using customer-oriented performance information. Balance this information with technical analysis and make sure that the customer information you generate is credible and has statistical integrity.

- Different applications of performance-based planning to various processes (long-range planning, MIS, etc.) require their own types of performance measures.

- One valuable approach to developing a manageable set of performance measures may lie in a two-tiered system, which would include "core" measures and secondary measures.

3.4 Saratoga Springs, NY (AMPO)

The Association of Metropolitan Planning Organizations (AMPO) held their third annual conference in Saratoga Springs, September 3-6, 1997. It was the team's desire to devote one of the workshops specifically to MPO issues, and the AMPO conference provided that opportunity. Team member Sarah Campbell conducted the workshop on September 4.

General Comments

The workshop facility was designed for 10 to 12 people; however, nearly 40 people arrived. One of the key reasons that the workshop proved popular was because there had been a provocative and confrontational presentation on the subject at a previous conference in June 1997. At that time the presenter told participants that performance measures were basic to the MPO business (i.e., everything they did could be quantified) and that, once selected, the measures would be used by the federal agencies to evaluate the MPOs. Partly as a result of this previous presentation, the audience's view of "hot issues" and "good measures" were different from what the research team heard from state DOT staff.

As the September workshop proceeded, it was clear that the group had some strong opinions about performance measurement. When an overhead slide depicting numerous "Dimensions of Performance" was presented, the group paused to discuss the issue of "environment and community values," and how this issue could be addressed in a performance-based planning process. This caused several MPO representatives to express the view that much of their work involved finding ways to incorporate these less-quantifiable issues into decision-making, and that they should be recognized as important even though less amenable to quantitative measurement.

Specific Topics and Views Expressed

The AMPO workshop offered a wide-ranging discussion that elicited a number of strong opinions. The following general concerns were made clear:

- There is a need to recognize qualitative measures, and the fact that some important aspects of transportation and MPO business are not given to "hard measures."

- The emphasis should be on output for some activities and on outcomes related to goals for others.

- MPOs want a "tool kit" that allows users to understand what are effective measures for various activities; what it takes in time and resources to develop them; and how they have been used in various settings.

- MPOs do not want measures for organizational assessment. There is a concern that these will be used for comparisons between MPOs and with other sister transportation agencies such as city or state DOTs or public works planning agencies.

- The state-of-the-art of performance-based planning should be recognized as uneven across agencies and geography.
- There is a need to develop and apply measures that are mode neutral.
- We should recognize political nature of process of selection and concern that measures will be used "politically" for comparison between metro areas by federal agencies.
- Available data is often not what is needed for the desired performance measures. How much data gathering is worthwhile in terms of time and money?
- Many participants see performance measures as a potentially useful tool to explain to the public why transportation is important. They feel that national studies, such as NCHRP 8-32(2) should do this, and then worry about measures for individual MPOs or other transportation agencies later. Generally they see the need for help in getting buy-in from local officials for consistent investment.
- A good measure should be determined by local goals and priorities. That is, the measure should track progress toward local goals. These may not be the same place to place. Hence, not all performance measures fit all jurisdictions' requirements.
- Recognize difference between tracking performance of transportation system in a region and assigning responsibility. Some good measures may reflect multiple agency efforts. (One of many reasons why they are against agency report cards.)
- Several participants found measures were useful in TIP decision-making, but all would like help on better measures for project scoring.
- The amount and nature of data required for the measure is an issue. How many performance measures are needed to help guide decisions or chart progress overtime? The group generally favored the "few good measures" approach.

3.5 Washington, DC (1998 TRB Annual Meeting)

The fourth workshop held as part of Phase II of this project took place in Washington, DC on Sunday January 11, 1998. Participants from a wide variety of agencies and geographic locations were invited to attend. The workshop was intentionally not announced in the TRB Annual Meeting program in order to help limit attendance to a size that would permit direct and detailed interaction between the audience and the research team. A total of 16 participants attended, along with five members of the research team. Participants represented several state DOTs, several MPOs, the FHWA, and consultants to the public and private sector transportation industry. The workshop lasted approximately three hours, over half of which was dedicated to discussion among the participants.

General Comments

One of the general comments expressed by several audience participants at the outset of the discussion period is that the kind of information being generated by NCHRP Project 8-32(2), as evidenced by the workshops and other presentations attended over the past months by research team members, is of great interest to transportation agencies. The information discussed thus far was described as "very germane" to what agencies are trying to accomplish, and that they would expect the products of the study to be quite useful. As in past workshops, audience participants inquired about the status of published results and exhorted the research team to do what they could to complete the work in a timely fashion, and equally importantly, see that the results are distributed without undue delay.

Topics of Discussion

Research team members summarized the findings of the numerous case studies completed for the project, focusing on themes including the debate over the intended application of performance-based methods, the significance of outcome measures, the perspective of different levels of government (DOTs, MPOs, transit operators, etc.) and other key themes that have emerged from the research. Audience participants responded to these issues and introduced additional ideas and opinions, as summarized below.

Intended Application of Performance Measures

- Monitoring of performance is widely supported, but the use of measures as standards for measuring success is not.

- The use of performance measures to prioritize programming decisions is also a subject of debate, with a good range of opinion. The application of performance measures in this context in some states was described as a failure, and it was noted that it is "not the job of management" to attempt to replace a political process with a technical one.

- Participants agreed that performance-based planning does not replace any process, but merely improves it. A better-informed, if still inherently political decision-making process, is all that might be expected. Results will vary from state to state!

- One way to effect more substantial change in the politics of decision-making is to use performance-based methods to better educate and inform the public, thus influencing their expectations and possibly driving further changes in the political process.

- In some states, performance measurement is being implemented specifically to provide a greater degree of local determination over planning.

- "Mission Overlap" needs to be understood by transportation agencies in their application of performance measures. For example, DOTs need to work more closely with economic development agencies to effect any real progress on "welfare to work" agendas. This federal example will have analogs at the state/local level.

- Representatives from DOTs and MPOs have stressed the point that they do not favor organizational performance measures; they are interested in system performance. (Of course, this view is not be shared by all elected officials or decision-makers who have commented on the matter.)

Outcome Measures

- An "outcome" measure is that only if it measures something that the agency has a specific program, the intent of which is to influence that outcome.

- The ability to directly control outcome is not a prerequisite to measuring outcome. This echoes comments heard at the Montana workshop. A representative from a different state this time again used safety as a key example of how performance information can be used to diagnose problems and then devise actions and strategies to achieve policy objective by partnering with other agencies, e.g., highway patrol, DMV, the justice system, schools, etc.

- Some question whether public expectations of outcome are realistic. External trends (in-migration, shift to a service economy, etc.) need to be taken into consideration before establishing measures and standards.

- While an agency can monitor and track things which effect outcome but which they do not directly influence, they might not want to call them "performance measures."

Process Issues

- There are significant regional differences, not only in the thresholds/standards that are set as targets, but in the measures themselves. At the state level, for example, congestion may be a noteworthy issue in only a few districts; and/or, the way in which congestion is defined and measured may be different. Using this example, it might be better to define mobility as the area of interest, and congestion as but one measure of mobility. In rural areas, measures other than congestion will be used to define relative progress towards improved mobility.

The Scope of Performance-Based Planning

One of the most significant topics discussed by participants in this workshop centered around the scope of performance-based planning. That is, to what extent should transportation agencies (or perhaps others) broaden the range of measures they employ, beyond measures of transportation system performance and outcome, to measures of success in attaining the overall future vision for a region or state. While the first phase of this research project talked about transportation's contribution to broad societal objectives such as economic development, quality of life, and environmental protection, the model to date focuses on measuring the outcome *within the transportation system* as it relates to these more broad societal objectives. Some have argued that until the scope of measurement is broadened to include a more comprehensive look at these societal goals, they will not be achieved. The argument is that if only transportation system measures are used (e.g., what is the transportation system's contribution to air emissions, not what is the overall air quality) then any regional or state plan can be made to look successful. In reality, because of a variety of behavioral actions and decisions that are made outside of the small arena of public transportation planning and investment, the net effect of the system contribution will be quite small and probably overwhelmed by external factors.

This discussion points out the importance for an agency to determine early on what they are actually trying to accomplish through implementation of a performance-based methodology. The answer to this question will determine what an agency should measure and how the information should be used.

4.0 Suggested Topics for Further Research and Product Development

The research project turned up three general areas where additional research and development of products would have clear value. These are improved data collection methods, improved analytical tools, and better methods of information distribution and sharing.

4.1 Analytical Tools

Although there are numerous performance-based planning processes now underway in the transportation sector, our research suggests that even today there is insufficient emphasis placed on objective measurement of the outcome or effectiveness of alternative system investments. The historical bias towards measures of system output and efficiency has been carried forward in part due to limitations in data and analytical models. Agencies have thus had difficulty developing and applying measures that are descriptive of system performance in terms that are more meaningful to users, such as travel time in specific corridors, predictability of trip duration, etc.

Many agencies have neither the staff resources nor the analytical tools to develop the new generation of outcome-based measures that would greatly add to the value of performance measurement. We have found numerous situations where an agency desires to adopt measures of accessibility and mobility, for example, but is ultimately constrained not only by the lack of current data but also by the inability to estimate values for important data under hypothetical future scenarios.

The problem is a result of at least two major factors: The absence of appropriate analytical tools among agencies, and the high initial and ongoing costs of applying and maintaining certain kinds of tools. The two causes are related, of course. The relative shortage of easy to use, widely distributed models and tools restricts access for many mid- and smaller-sized agencies. Because of this, human resources to apply the models are more scarce and more costly that would otherwise be the case.

It is true that a large number of cities, counties, MPOs and other special purpose local and regional agencies have (or have access to) a traditional travel demand forecasting model. The research confirms, however, that the majority of these models are limited in their ability to produce information that is useful in generating more advanced measures of outcome and effectiveness. For example, numerous participants in the workshops expressed skepticism about the ability of their agency's models to predict transit ridership, non-motorized, truck trips, or even non-work auto trips, with any accuracy. Most models start out with the objective of forecasting future peak hour or daily auto trips, and many do not progress beyond that stage. Thus, the models are limited to producing estimates of roadway V/C ratio and several derivatives (e.g., average speed, aggregate delay, total VMT, etc.) Useful measures of mobility and accessibility often require more disaggregate information, for example, average travel time to major employment centers, or percentage of a population that can reach specified services within a given travel time. Extracting performance measurement data such as VMT in a specified corridor or point-to-point travel times is usually a tedious manual process.

In a similar way, some larger agencies are making significant progress in the application of geographic information systems (GIS) technology to transportation planning and modeling. These systems greatly facilitate generation of measures that combine some form of spatial data (e.g., density, income, auto ownership or other population characteristics) with transportation data (location of transit facilities, designated freight routes, etc.) For many other agencies, however, the necessary investment in the development, use, and upkeep of an integrated GIS is prohibitively expensive.

One additional glaring area of analytical limitation is in the longer distance, intercity markets that state DOTs are concerned with. Relatively few states have working statewide models that can be used to evaluate, for example, investment in alternative intercity travel modes.

Useful additional research and product development, therefore, would include those efforts focused on developing *and disseminating* lower-cost analytical tools, especially forecasting models and geographic information systems, to potential users. Suggestions include:

- Continue efforts sponsored by FHWA and others to improve the state of intercity and statewide forecasting and distribute information to potential users.

- Continue efforts to disseminate the results of projects such as the Travel Model Improvement Program (TMIP) to agencies around the country, with appropriate attention to improving model system components such as mode choice models and "post processors" which can significantly improve one's ability to generate system performance data.[1]

- Support the further development and deployment of sketch planning methods for evaluating alternative transportation alternatives. A number of these models have been developed which provide a lower-cost approach to screening alternatives and determining relative impacts and benefits of different transportation projects and strategies. In recent years, FHWA has sponsored development of such tools which provide comparative evaluation of different modal investments and even intelligent transportation system (ITS) strategies. Further work is required to refine, document, and deploy these lower-cost sketch planning benefit models to a larger cross section of public agencies.

[1] Post processors include a variety of analytical models developed to use travel demand model output to generate more accurate estimates of a variety of factors, such as speed, queuing, spreading of peak demand over a longer time period, etc.

- Generally speaking, more funds should be devoted to the broad distribution of numerous analytical methods and tools that have already been developed. Examples include the "Quick Response Freight Manual" and the "Short-Term Model Improvement Program" which could probably benefit a wider audience if more funding were available for training and user support.

4.2 Data Collection and Maintenance

The Phase I research confirmed that collecting and maintaining data to support performance-based planning programs is a critical obstacle. The vast majority of agencies we visited or spoke with indicated that their data collection resources are limited; that existing data collection programs will continue to consume most of the available resources; and that it is difficult to convince executive decision-makers and others of the need for and value of additional or different data collection programs.

Existing data collection methods tend to be labor intensive and thus expensive. Because they are expensive, they tend to be done periodically rather than continuously, and thus do not do a good job of reflecting the dynamic nature of transportation system conditions. Whether for highways or transit, most current methods require some form of manual surveillance and data reduction.

In the area of freight movements, these constraints are even more apparent. Freight shipments are more varied in content, and vary more over time, than passenger movements, so accurate data collection is a complex, costly process. Cooperation from the private sector has been limited due in part to concerns about competitiveness and security reasons.

Surveys have been used by many agencies to collect a variety of data with value in the performance measurement context. These include a variety of "user" surveys, customer perception and satisfaction surveys, goods movement surveys, etc. Some agencies have placed a great deal of emphasis on customer surveys, while others have openly questioned the usefulness of customer perception and opinion data. Like manual data collection, these methods are expensive, and are perceived by some to be disruptive or invasive. For these reasons, they tend to be done infrequently.

The most dramatic payback would appear to come from further investment in deployment of ITS technologies that will accelerate the shift towards automated collection of a wide variety of transportation data. Equally important is the fostering of partnerships that will help bring that data in a useful format to a wide variety of public and private users. Section 4.0 of the Phase I draft Final Report (reproduced in Appendix B of this report) provides additional discussion of the current data collection and manipulation methods, shortcomings, and benefits of future methods that rely on emerging ITS technologies.

4.3 Information Sharing

The issue of disseminating technology has already been raised above. When new methods are developed, it is important that they are not "abandoned" or left on the shelf waiting for potential users to discover them. The above examples indicate that this is true specifically of analytical methods and tools, but it is also true generally of the performance-based planning methodology and base of experience that is accumulating at a number of sites around the country.

Because of the rate at which additional agencies are testing performance measurement methods, it is difficult for any research publication to remain current for very long. It has become apparent during the course of conducting the case studies that information becomes dated quickly and opportunities for leveraging or "piggy backing" off the experience of others are lost because information travels slowly and erratically.

To help address this situation, we suggest that relevant research products be made available to interested parties in electronic format. Whether through CDs or over the World Wide Web, products such as the Performance-Based Planning Manual would reach a larger audience more quickly if distributed in this fashion. A very important by-product of this method of distribution is that it would be relatively simple and inexpensive to set up a two-way forum for commentary and discussion on the usefulness of such products. If practitioners were able to provide direct feedback on their experiences in applying the research products in their own situations, it would also be possible to develop a continuously updated reference manual takes incorporates this more recent information and makes it available to a larger audience. Again, the key point to be made is that when a field of knowledge is moving through a period of rapid growth and a "steep learning curve" it is going to be more difficult for traditionally-published reports to stay on top of developments and provide current information.

Appendix A

Case Studies

Case Study: Albany

1.0 Introduction

1.1 Key Learning Points

- CDTC approached performance-based planning through a consistent alignment of performance considerations from system-level performance measures to project-level evaluation criteria.
- CDTC used the total cost accounting (TCA) approach as one of many tools to assess performance measures and undertake performance-based planning.
- TCA involves the estimation of the social cost for a proposed investment based on actual direct or indirect monetary costs. CDTC considered other impacts that do not involve such a monetary transaction to be addition performance considerations, but not part of the TCA cost calculation.

The Capital District Transportation Commission (CDTC) is the designated MPO for the four-county area surrounding Albany, Schenectady and Troy, New York. The area served by CDTC contains approximately 800,000 residents in several small industrial cities surrounded by more recent suburban development. The CDTC area had been a marginal non-attainment area for ozone, but was re-designated a maintenance area in 1994.

CDTC includes 12 relatively senior professional and support staff who provide technical analysis, support, and guidance to the policy board (the decision-making body) and the planning committee (the technical advisors to the policy board). The CDTC policy board is comprised of representatives from the four counties, eight cities, and a rotation of the towns and villages in the region. Additional board members include representatives from the regional planning commission, transit authority, airport authority and port commission, as well as the state transportation department and thruway authority. Planning committee membership is structured similarly to the policy board.

The policy board operates by unanimous consent of the affected parties, which typically means that **all** board members must approve a measure. This structure has placed a premium on cooperation and compromise, as well as on availability of objective information to help guide decision-making.

Benefit-cost (B/C) analysis has been an important component of this objective information for over 20 years. As in most other area, B/C analysis at CDTC had traditionally relied on monetarized values for safety, travel time and congestion. In 1993, however, CDTC began their *New Visions* process, a comprehensive update to their long-range regional transportation plan. As part of this process, CDTC adopted a new set of "core performance measures"; these new measures relied, in part, on a broadened approach to B/C analysis that is best described as "total cost accounting" (TCA).

The TCA approach is an attempt to systematically account for all potential impacts or costs arising from a transportation investment. This accounting may be either in monetary, non-monetary quantitative, or qualitative terms depending upon what is most appropriate for a given impact or cost. The TCA approach is one of may tools used by CDTC to evaluate performance measures as part of their performance-based planning process. This case study reports on CDTC's use of performance measures in New Visions, with a particular focus on their total cost accounting approach.

2.0 Process Background

As mentioned previously, CDTC's organizational structure supports objective decision-making. This environment stems back to the founding of CDTC in the 1960s, and was most pronounced in the process established in 1977 to select Interstate Substitution project, and in the Project Information Procedure developed in the 1980s to assist in project selection within certain categories.

In 1992, CDTC modified their TIP process to address increased programming flexibility brought about by ISTEA. The process and issues addressed in this TIP update provided the foundation for New Visions. Essentially, the 1992 procedures involved a three-step screening, scoring, and programming sequence as illustrated in Figure 2.1. The 1992 process involved screening projects for consistency with existing plans and minimum thresholds. Projects were then scored on a consistent set of criteria including monetary, non-monetary, and descriptive measures. Finally, projects were programmed (based in part on scoring) to provide balance among project types, project sponsors, and geographic area.

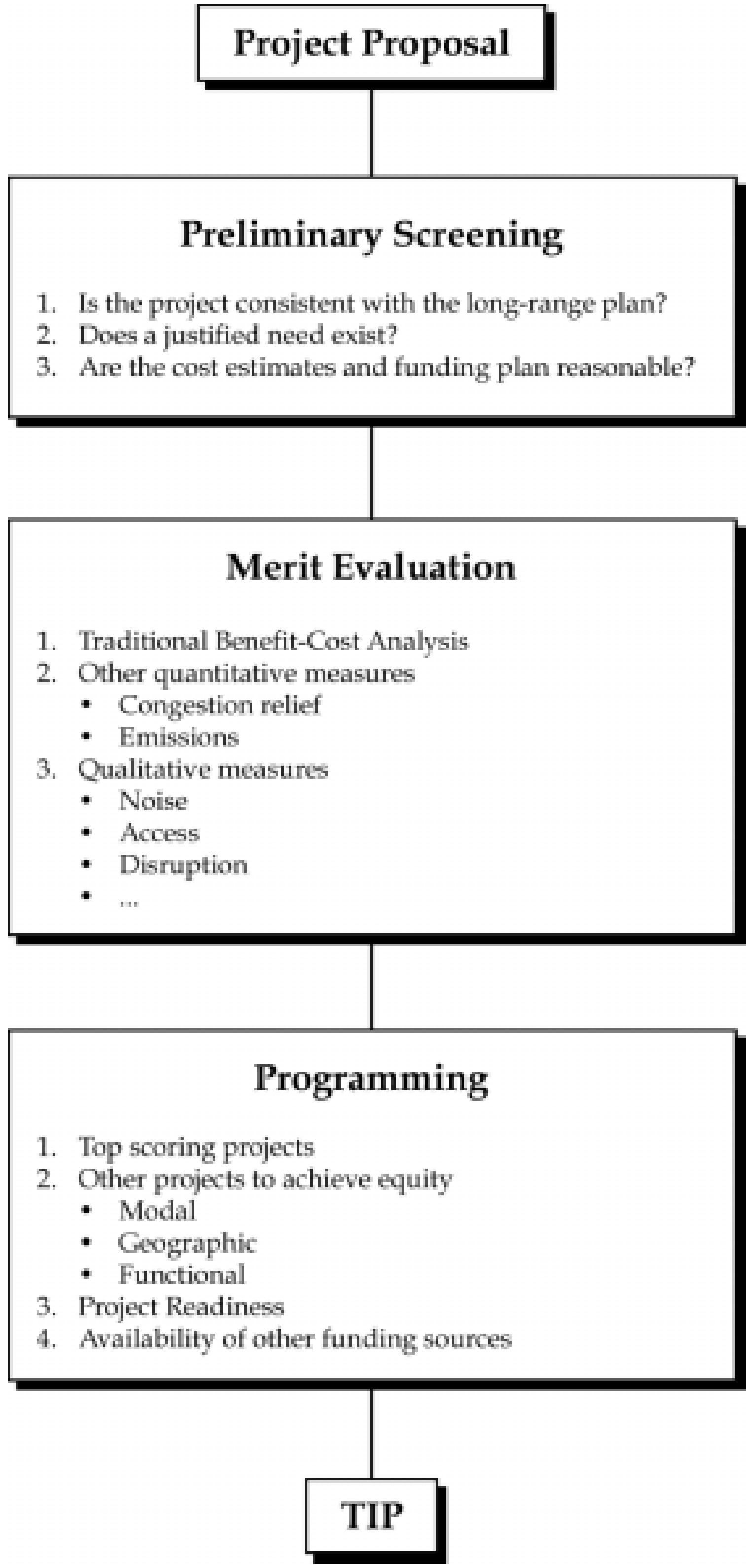
The scoring process in the 1992 TIP update was not based on the TCA approach since the necessary technical tools had not been finalized. However, the structure of the scoring process, which was later adopted in the New Visions performance measures, reflected CDTC's thinking that:

- Some impacts can be legitimately presented in monetary terms (CDTC calls these impacts *monetary expenses*);
- Other impacts can be quantified, but should not be monetarized (CDTC calls these impacts *abstract values*);
- Other impacts cannot be easily quantified, but should be discussed in narrative fashion (CDTC calls these impacts *distributional effects*); and
- All three types of measures are important and should be available for the decision-making process.

These four elements are the essential characteristics of CDTC's TCA approach. It is a hybrid between their former evaluation process that relied on traditional B/C analysis, and the least-cost planning approach widely used in the electric utility industry.

Least-cost planning is based on the conversion of **all** impacts into monetary terms. However, the TCA approach does not assume that all impacts can be represented in the common denominator of dollars. Under TCA, impacts that can be converted into monetary terms based on an **actual direct or indirect monetary cost** combine to represent system cost. Other impacts that are distributional or do not involve a pecuniary cost represent additional performance measures, but are not reported in monetary terms.

Figure 2.1 1992 CDTC TIP Development Process



TCA also differs from traditional B/C analysis in two key ways. First, TCA includes costs for many environmental impacts that typically are not included in B/C analysis. Second, TCA assigns a monetary value to travel time only for commercial and other on-the-job travel; all other travel time, such as for commuting, is quantified but not monetarized since no monetary transaction is involved. In B/C analysis, all travel time costs are typically monetarized.

3.0 Process Application

CDTC traces the roots of their New Visions process, and the TCA approach, back to the mid- to late-1980s when decisions were made to invest in enhanced data collection, staff training, and upgrades to models and other analysis tools. Over a six-year period, major CDTC efforts to improve analysis capabilities included:

- An ongoing vehicle and pedestrian count program at major intersections off of the state highway system;
- A pavement condition database for non-state, federal-aid roadways;
- An inventory program for driveway frequency and sidewalk location on most arterial roadways;
- Development of locally calibrated trip rates for major generators;
- Incorporation of a mode choice model into the travel demand model;
- Development of simulation models to test peak spreading and delay impacts;
- Development of an integrated land use model to measure transportation/land use interaction; and
- Development of routines to test traffic impacts of maintenance projects.

CDTC shared some of the data collection responsibility with local agencies and the regional planning agency. However, most background work, as well as subsequent efforts for the plan and TIP update, was performed by CDTC staff within available resources; use of outside consultants was extremely limited. None of the individuals contacted for this case study could recall an instance in which the professional judgment or technical evaluation of CDTC staff was questioned. Individuals outside of CDTC expressed high levels of praise for CDTC management, staff, and work products.

CDTC began the New Visions process in 1993 on the heels of the 1992 TIP update. Based on initial public input, CDTC formed nine task forces to investigate particular sub-elements of the overall plan. CDTC identified a set of initial issues, and then asked the individual task forces to help develop and agree to a set of core performance measures which would guide the work of all task forces. These measures, which became the foundation for all future work, are illustrated in Figure 3.1. As shown in the figure, the core measures are a mixture of monetary, non-monetary, and descriptive qualities. Also, the Economic Cost measure has a direct correspondence to the TCA approach.

Figure 3.1 Core Performance Measures

CORE SYSTEM PERFORMANCE MEASURES

Transportation Service

Access:	What travel alternatives exist? *(Measure: Percent of person trips within a defined non-auto (walk, bike, transit) to auto time difference[1]; percent of person trips with a travel time advantage for non-drive-alone modes (including carpools); number or percentage of major freight movements with modal alternatives[2])*
Accessibility:	How much time does travel take? *(Measures: travel time between representative locations, including major intermodal facilities; peak vs. non-peak, by quickest mode)*
Congestion:	What is the level of exposure to traffic congestion? *(Measures: excess delay: recurring, non-recurring by mode [auto, transit, freight, bike, pedestrian][3])*
Flexibility:	Can the system respond to unexpected conditions? *(Measures: reserve capacity on system[4]; percent of person trips that could be accommodated by modes other than auto in an emergency[5]; number of corridors with reasonable alternatives during closure or disruption[6]; amount of risk associated with fixed capacity investment[7])*

Resource Requirements

Safety:	What are the safety costs associated with transportation? *(Measure: estimated societal cost of transport. accidents)*
Energy:	How much energy is consumed in providing, maintaining and using the transportation system? *(Measure: equivalent gallons of fuel / day for transp. capital, maintenance, operation and use)*
Economic Cost:	How much does the transportation system and its use cost, in addition to safety and energy costs? *(Measures: annualized capital, maintenance, operating and [monetary] user costs for transp. system; value of commercial time in travel)*

External Effects

Air Quality:	What is the effect of the transportation system on air quality? *(Measures: daily emission levels (HC and NOx); air quality attainment status)*
Land Use:	How does the transportation system affect land use? *(Measures: amount of open space; dislocation of existing residences and businesses; land use - transportation compatibility index[8]; community quality of life measure[9])*
Environmental:	How does the transportation system affect key environmental features? *(Measures: impacts on sensitive areas [wetlands, parklands, historic areas, archaeological sites, etc.); noise exposure index[10]])*
Economic:	How does the transportation system support the economic health of the region? *(Measures: narrative discussion of economic-activity supporting or constraining features of transportation system)*

Figure 3.1 Core Performance Measures (continued)

NOTES

[1] Suggested maximum acceptable time difference is approximately 15 minutes; up to 20 minutes for longer trips; values may be summarized by sub-region (central cities, inner suburbs, outer suburbs, small cities and villages, rural areas).

[2] While choice of mode for freight movement is largely decided by cost factors, availability of alternative modes is a measure of access.

[3] Person hours used for all values except for truck traffic, for which vehicle hours is more relevant.

[4] Reserve capacity is defined by corridor and is modally-weighted.

[5] Maximum value derived from access value (see footnote 1), further constrained by non-auto system capacity (bus capacity, etc.).

[6] Reasonable alternatives for personal travel during closure or disruption of a highway facility would include transit (if on a separate right-of-way) or parallel highway facilities; reasonable alternatives for freight primarily include parallel highway facilities within a few miles' distance. Modal alternatives for freight are best captured under access measures (see footnote 1.)

[7] Risk is defined as the "opportunity cost" of over-investing or under-investing in a capital project if projections of conditions prove incorrect. Examples would include loss of rights-of-way that become needed in the future; construction of fixed highway or transit capacity predicated on future demand that does not materialize; construction of facilities at conservative scales that turn out to be under-sized.

[8] Index is primarily based on levels of traffic or other transportation intrusion in residential areas, defined as daily traffic divided by average residential driveway spacing. Also includes a measure of compatibility between arterial function and local access function, defined as daily traffic divided by average commercial driveway spacing.

[9] Measure is a combination of quantitative and qualitative factors that reflect community quality of life by subregion (central cities, inner suburbs, outer suburbs, small cities and villages, rural areas). It is intended to measure how the transportation system (in existing and alternative future scenarios) affects land use and other conditions within a defined "community". Socioeconomic factors such as population and employment shifts, are combined with measures of mobility, documentation of real estate and road ownership patterns, and cultural factors to paint a picture of how transportation, and its interaction with land use, has influenced our quality of life at the community level.

[10] Index is primarily based on product of dB_a and number of households in areas in which dB_a exceeds accepted thresholds.

The nine task forces were also charged with:

- Developing supplemental measures relevant to their subject areas;
- Identifying issues in a White Paper;
- Guiding the technical work performed by CDTC staff;
- Suggesting planning and investment principles;
- Recommending reasonable actions for the consensus plan; and
- Identifying other policy issues for future public debate.

This set of directives required task force members to focus on realistic options for the investment plan, while still addressing more visionary elements through policy suggestions.

From the perspective of this case study, one of the more interesting charges to the task force was the development of supplemental performance measures. These measures, such as those displayed in Figure 3.2 for the Transit Futures Task Force, allowed each task force to consider measures and criteria that are more common in their specific areas and may be more helpful in making tradeoffs. However, the task forces were required to relate their final recommended action in terms of the core performance measures. (See Figure 3.3 for example from the Arterial Management Task Force.) This is an example of linking broad system performance measures to criteria for evaluating cost-effective strategies in individual applications.

Figure 3.2 Supplemental Performance Measures for Transit Futures Task Force

Traditional Cost-Effectiveness Measure
(Cost Per New Rider)
Values are Rough, Based on System-Level Analysis

	Free Fare	App 1 (LRT)	App 1 (LRT, urban)	App 2 (LRT)	App 2 (Bus)	App 3 (LRT)	App 4 (CR)
Total Rail System and Guideway Capital Cost ($M)	0	343.5	343.5	386.6	100.0	307.1	154.1
Marg. Annual Cap. Cost ($M)	0	25.80	25.80	29.00	7.70	22.69	11.89
Marg. Annual Oper & Maint Cost ($M)	10.6	9.97	9.97	9.83	4.22	5.11	10.77
Total Marginal Annual Cost ($M)	10.6	35.77	35.77	38.83	11.92	27.80	22.66
Total transit riders, 2015							
PM Peak hour	7,160	8,150	8,340	7,623	7,623	7,760	7,396
Daily	57,300	62,250	63,200	59,615	59,615	60,300	58,480
Annual	14,898,000	16,185,000	16,432,000	15,499,900	15,499,900	15,678,000	15,204,800
New Transit riders (over null, same frequency), 2015							
PM peak hour	1,310	2,300	2,490	1,773	1,773	1,910	1,546
Daily	6,550	11,500	12,450	8,865	8,865	9,550	7,730
Annual	1,703,000	2,990,000	3,237,000	2,304,900	2,304,900	2,483,000	2,009,800
Total cost-effectiveness ratio ($)	6.21	11.96	11.05	16.85	5.17	11.20	11.27
Annual Travel Time savings ($M)	0.64	8.59	49.40	6.57	6.60	6.63	3.26
Net cost-effectiveness ratio including travel time savings ($)	5.83	9.09	no net cost	14.00	2.31	8.53	9.65

Notes

Total capital cost for rail systems includes guideways, vehicles and other capital investment.
Total capital cost for busway is limited to the highway work.
Marginal capital costs for investment annualized at 7%, 30 years.
Marginal capital and operating costs are net after savings in bus capital and operating expenses.
New riders are relative to 5,850 PM peak hour riders under null service, 1990 frequency.
Applications all include improved transfer system, doubled downtown parking costs.
(Transfer and parking actions account for approximately one-half of new riders shown.)
Daily new riders = PM peak hour new riders x 5.
Annual new riders = Daily new riders x 260.
Travel time savings is net for all modes (auto, truck, transit, walk, bike), including walk and wait time.
(Net travel time savings is dependent upon assumptions about effects of peak hour mode shift on daily vmt, avg. transit speeds.
Cost effectiveness ratio is defined as marginal annual costs / annual new riders.

Figure 3.3 Summary of System Performance Measures for Arterial Management Task Force

CORE MEASURES		Trend 2015 Conditions With Current Commitments	2015 Conditions Arterial Management	Qualitative Summary Impact
Transportation Services				
ACCESSIBILiTY	Travel time on the Surface Arterial Highway System (hours) Region / Inner Suburbs	63,200 / 30,240	60,390 / 28,035	✓ / ✓
	Travel Speed in a Typical Developed Corridor (mph) (Central Ave as an Example)	25	32	✓✓
CONGESTION	Corridor Peak Hour Excess Vehicle Delay (hours) Region / Inner Suburbs	6,015 / 2,990	5,890 / 2,730	✓ / ✓
	Intersection Excess Peak Hour Vehicle Delay (Region)	4,140	4,250	✖
FLEXIBILITY	Reserve capacity on the Surface Arterial System (PM Peak Hour Vehicle Miles of Capacity)	371,190	410,800	✓✓
Resource Requirements				
SAFETY	Number of Midblock Crashes	8,230	6,085	✓✓
	Estimated Annual Societal Cost of Midblock Transportation Crashes (Millions of Dollars, $M)	$339 M	$250 M	✓✓
	Estimated Annual Societal Costs of all Transportation Crashes ($M)	$1,065 M	$1,005 M	✓
ENERGY	Daily Fuel Consumption (gallons)	719,105	711,800	✓
ECONOMIC COSTS	Total Annual Planning & Direct Implementation Costs ($M)	$0.2 M	$0.8 - 1.5 M	✖✖✖
	Estimated Annual Public Planning & Implementation Cost ($M)	$0.1 M	$0.2 - 0.4 M	✖✖
External Effects				
AIR QUALITY	Daily Hydrocarbon (HC) Emissions (kilograms)	17,640	17,650	
	Daily Nitrogen Oxide (NOx) Emissions (kilograms)	18,550	18,560	
LAND USE	Residential Use Traffic Conflict: Miles at LOC "E" or "F"	139	92	✓✓✓
	Arterial Land Access Conflict: Miles at LOC "E" or "F"	77	45	✓✓✓

✓✓✓	Positive impact between 20% & 50%	Negative impact between 20% & 50%	✖✖✖
✓✓	Positive impact between 10% & 20%	Negative impact between 10% & 20%	✖✖
✓	Positive impact less than 20%	Negative impact less than 20%	✖
	Negligible impact expected		

Most of the task force work was completed over an 18-month period through late 1995. CDTC staff had the responsibility of pulling together the action and policy recommendations of the task forces. This work, which preceded drafting of an "official" plan, was performed during 1996, and was accompanied by an open conference of all the task forces, publication of a "workbook" of task force results, and over 50 local public meetings. Only after this outreach effort did CDTC staff prepare a plan that was again sent out to public meetings and officially circulated for review. The final plan was approved, with very few changes from the Draft, in March 1997. Individuals contacted for this case study indicated that the final plan was very reflective of task force deliberations and recommendations, and left most individuals feeling that their participation made a difference in the outcome.

Plan adoption was followed immediately by efforts to update the TIP. The TIP update was approached as an extension of the plan, with a revised screening, scoring and programming process from what was used in 1992. This connection was achieved in the following fashion:

- The project-level merit evaluation for the TIP was based on explicit evaluation of the core performance measures from the plan.

- The TCA approach from the plan was applied to each project, with the value used as a major consideration in the selection of projects during the first of three rounds of programming. (The subsequent two rounds focused on qualitative merit and projects with strong political or public support.)

- Fiscal constraint was achieved at the plan level by identifying target budgets in 21 major project categories; programming decisions were made in part to provide balance with the plan targets.

This attention to plan/TIP linkage, combined with extensive outreach, three rounds of project selection, and the decision to honor prior programming commitments before any new projects were selected helped the TIP update occur rapidly and with relatively little controversy.

While CDTC's TCA approach has garnered national attention, it did not have a major impact on most task forces, or in subsequent deliberations by the planning and policy boards. The most notable exceptions were the Transit Futures and Expressway Management Task Forces, where TCA was particularly well suited for deliberations on large systemwide investment options. The TCA approach was seen by individuals outside CDTC as a logical extension of prior evaluation routines, and a reasonable manifestation of local desires to 1) more explicitly incorporate environmental costs in planning, and 2) "level the playing field" between projects in different modes.

Within the Transit Futures Task Force, TCA evaluations were run on seven different system alternatives and four limited subsets (called "corridor applications" by CDTC). The TCA approach helped determine the extent of land use and pricing changes which would be required to achieve a net social benefit from no action, and persuade modal advocates to agree to a staged approach focusing on building the necessary support mechanisms in the near term. Figure 3.4 presents TCA results for no action and three other alternatives under both trend conditions and an aggressive pricing/land use strategy. Figure 3.5 illustrates how the pricing land/use strategy was also shown to be supportive of key supplemental performance measures for the Transit Futures Task Force.

Although new approaches, such as TCA, are sometimes accompanied by controversy, this was largely not the case at CDTC. The marginal costs were developed from both local experience and national research; the specific sources are identified in Figure 3.6. CDTC staff aimed to develop reasonable marginal costs, recognizing that there was no "perfect" value. The only controversy surrounding the TCA approach involved the decision to measure but **not** monetarize non-commercial travel time; as noted previously, all travel time is usually assigned a monetary value in the traditional B/C approach. CDTC contends that transportation changes have tended to induce land use changes rather than travel time changes; the resulting changes are seen as distributional in nature rather than as the result of a monetary transaction. Others, however, contend that these land use changes are the result of market forces tied to transportation investment, and a cost can be inferred from people's actions. This issue certainly requires more research and discussion in the transportation field.

Figure 3.4 Annual Marginal Monetary Costs of Capital District Transportation

Annual Marginal Monetary Costs of Capital District Transportation
(1990 vs. 2015 for representative alternatives)

($ x 1000)

	Null trend	Best bus trend	Best bus pricing	FG 1 trend	FG 1 pricing	FG5 trend	FG5 pricing
Personal Vehicle Ownership	317,940	304,876	206,300	294,239	153,561	302,354	203,282
Personal Vehicle Operation	219,524	209,299	135,497	201,037	103,687	207,583	133,174
Parking-Work Trip	13,273	12,530	7,795	11,972	4,955	12,344	16,990
Parking - Other Commercial	7,760	7,325	4,557	6,999	2,897	7,216	9,933
Parking - Residential	30,320	21,173	21,173	29,368	20,889	30,957	21,173
Accidents - Full Cost	550,684	527,266	334,230	507,360	263,696	524,618	330,557
Time Spent in Travel - Commercial	92,489	91,101	81,762	89,083	75,332	90,455	81,182
Congestion Costs - Commercial	8,786	8,139	4,297	7,361	2,647	1,129	2,840
Highway Cap & Operating	116	8,485	8,489	520	(153)	745	749
Transit Cap & Operating	(10,575)	19,177	19,177	127,267	127,267	29,335	29,335
Transp-related Police/Fire/Justice	11,041	10,561	6,842	10,170	4,833	10,468	6,730
Regional Air Pollution	(19,296)	(19,424)	(21,006)	(19,610)	(21,828)	(19,397)	(20,985)
Global Air Pollution	38,612	37,401	25,503	36,147	18,848	37,310	25,348
Vibration Damage	1,231	1,271	1,272	1,287	1,206	1,278	1,279
Water Quality Damage	7,470	6,191	4,855	7,058	4,053	7,327	5,962
Waste Disposal	4,412	4,232	2,744	4,071	1,936	4,194	2,699
Energy - Security and Trade Effects	56,668	54,374	36,526	52,493	26,636	53,929	35,985
Subtotal: Marg. User Costs	898,449	868,171	1,056,007	846,856	907,145	856,877	1,015,797
Subtotal: Marg. Gov't Costs	90,589	110,453	(378,617)	206,727	(266,139)	120,426	(345,609)
Subtotal: Marg. Society Costs	341,418	325,351	202,623	313,508	149,454	324,540	216,045
TOTAL MARGINAL MONETARY COSTS	1,330,456	1,303,976	880,013	1,367,091	790,461	1,301,843	886,233
DIFFERENCE FROM NULL TREND		(26,480)	(450,443)	36,635	(539,995)	(28,613)	(444,223)
Marginal Personal Time Value	450,766	435,275	302,934	420,151	260,658	434,159	357,737
Difference from Null Trend		(15,491)	(147,832)	(30,615)	(190,108)	(16,607)	(93,029)
Tot. Marg. Personal and Comm. Time Value	543,255	526,376	384,696	509,234	335,990	524,614	438,919

Notes:

Costs shown are only those for which a monetary transaction occurs directly or indirectly.

Transportation system impacts on abstract (value of personl time spent in travel) or distributional factors (property values) are not included.

Relationships are documented in CDTC's "Estimated Marginal Monetary Costs of Travel in the Capital District", April, 1995.

For pricing options, scenarios assume highway use prices rise due to taxes or fees. Costs are incurred by users with payments to government.

Transit capital and operating costs for fixed guideway system 1 extrapolated from detailed estimates for Application 1, based on linear miles of system.

Costs for highway capacity expansion is assumed to drop from $20 M annually (base) to $10 M annually.

Cost for Northway buslane shown as $8 M annualized highway capacity cost for "Best Bus" scenario.

Personal time value estimated at $3.30 per person hour for door-to-door travel, all modes.

Figure 3.5 Effects on Access and Delay of Full System Alternatives

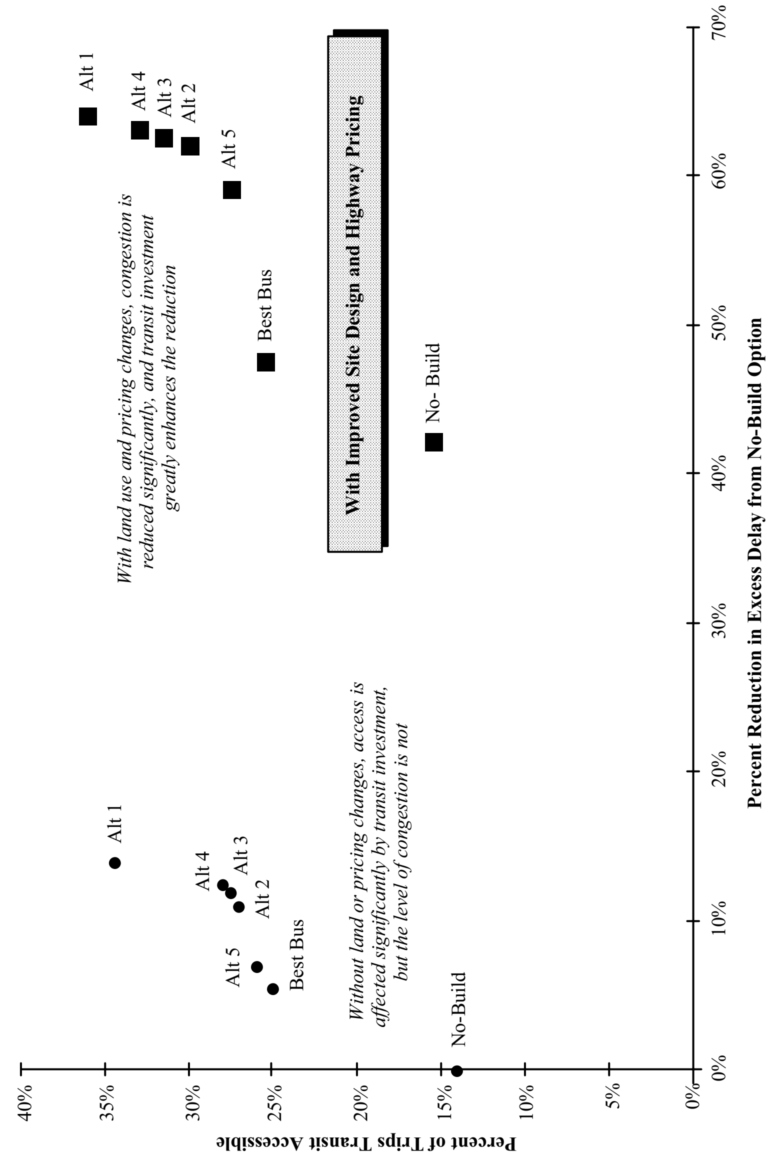
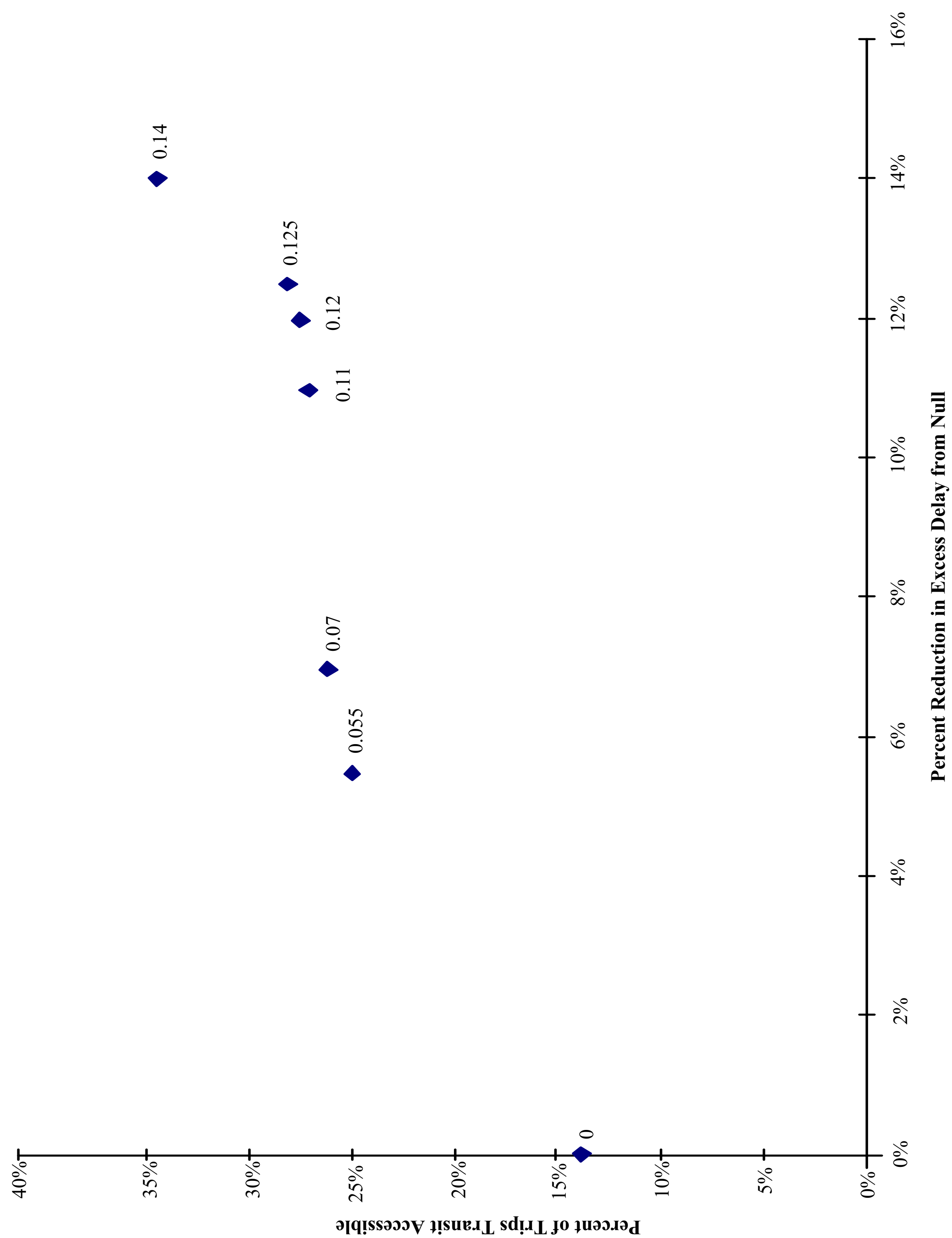


Figure 3.6 CDTC Sources for Estimating Marginal Monetary Costs of Travel

Cost Category	Principal Sources
Private vehicle ownership and Operating	*The Costs of Owning and Operating Automobiles, Vans and Light Trucks, 1991* (FHWA) *The Costs of Transportation: Final Report* (Apogee Research, 1994) *Characteristics of Urban Transportation Systems* (FTA, 1992) CDTC Systematic Travel Evaluation and Planning (STEP) model
Transit Fares	**Local experience**
Parking (commute, shopping and residential areas)	*The Costs of Transportation: Final Report* (Apogee Research, 1994) *Transportation Cost Analysis: Techniques, Estimates and Implications* (Victoria Transport Policy Institute, 1994)
Accidents	CDTC Systematic Travel Evaluation and Planning (STEP) model *Characteristics of Urban Transportation Systems* (FTA, 1992) *Transportation Cost Analysis: Techniques, Estimates and Implications* (Victoria Transport Policy Institute, 1994)
Commercial travel time and congestion	New York Department of Transportation *Transportation Cost Analysis: Techniques, Estimates and Implications* (Victoria Transport Policy Institute, 1994)
Highway maintenance	**Local experience**
Police, fire and justice expenses	*Transportation Cost Analysis: Techniques, Estimates and Implications* (Victoria Transport Policy Institute, 1994)
Air pollution	*Monetary Values of Air Pollution Emissions in Various U.S. Areas* (Wang and Santini, 1995) *Transportation Cost Analysis: Techniques, Estimates and Implications* (Victoria Transport Policy Institute, 1994)
Other environmental issues (vibration, waste, energy, water quality)	*Transportation Cost Analysis: Techniques, Estimates and Implications* (Victoria Transport Policy Institute, 1994) Locally calibrated assumptions

Figure 3.7 Effects on Access and Delay of Full System Alternatives



4.0 Process Impacts

As discussed in the prior section, the TCA approach had a relatively minor explicit impact on the planning process in the CDTC region. It was suggested that the "shape" of the final plan and TIP was more a reflection of the decision-making structure of the policy board (consensus of affected parties) than the performance measures or TCA. However, TCA was viewed as having an impact on selection of some new projects for the TIP since the B/C ratio (based on TCA results) was an explicit consideration in the first round of programming. Several opinions were expressed about why TCA played such a minor role, including:

- TCA was one of many new tools developed at about the same time;
- Significant attention was paid to non-monetary performance measures;
- All major projects from past TIP cycles were retained for the current TIP update, and relatively smaller projects were added; and
- Funding was adequate to provide some level of benefits in most program and geographic areas; an environment of hard or controversial tradeoffs did not exist.

Many individuals contacted for this case study stated that the core performance measures, including TCA, had a more subtle impact on the manner in which the plan and TIP updates were carried out. The overall process was viewed as more thorough due to the inclusion of non-traditional performance measures and projects rather than explicit quantification of some measures and costs. The use of core performance measures helped focus opposing viewpoints on task forces so that they were not discussing "apples and oranges."

The thorough technical analysis provided to the task forces by CDTC staff was mentioned by several individuals as providing real benefits. The entire cadre of tools (old and new) was able to provide tangible, credible evidence that even major policy shifts would have minor impacts on most performance measures; this information helped to quickly address calls for radical departures from existing conditions and policies. Rather than just dismissing these alternative viewpoints, however, the technical and policy analysis helped **explain why** an incremental approach was in the best interests of everyone in the region.

5.0 Experience and Lessons

There was a fair amount of consistency in the opinions expressed by individuals contacted for this case study. There was unanimous agreement that New Visions was a success for the CDTC region, and that other areas could benefit by experiences in the Capital District. The following six "lessons" are a summary of recommendations from the interviews:

The most important element of CDTC's success was the competency, reputation and leadership of staff and management from CDTC; an objective process cannot succeed unless the agency responsible for planning has credibility among key stakeholders and the general public.

All performance measures, including those related to TCA, should be viewed as a way to **assist** decision-making, not guide it.

Requiring the task forces to contribute and agree to a limited set of core performance measures assured that key stakeholders were "on the same page" for technical analysis and underlying policy assumptions.

A planning or implementing agency need not "fear" non-traditional technical approaches; thorough, fair analysis can produce results in-line with desires, expectations and logic while making everyone feel that their participation made a difference.

In this era of broader participation in transportation planning, it is important that the process not be intimidating to non-technical people. One individual expressed an opinion that while the quality of information provided by CDTC was excellent, the quantity of information was close to being burdensome, particularly for individuals without a transportation background.

A long-term commitment is required for development of data collection and analysis resources. The current process at CDTC reflects investment decisions made five to 10 years ago.

6.0 Future Plans

CDTC views the New Visions plan as long-term guidance for the region. There is a clear public expectation that the plan will be implemented, and CDTC does not expect that there will be major revisions to the plan within the next 10 years. The next few plan update cycles are not intended to be as large an endeavor as New Visions, and will likely be used for formal monitoring and feedback on plan implementation based on the core performance measures; CDTC is beginning internal discussions about how monitoring and feedback should be undertaken. Any necessary mid-course corrections indicated by the feedback would be incorporated into the plan update.

CDTC would like to incorporate the TCA approach into project development activities. However, they are not sure how to adapt the approach to the project level since early experience suggests that meaningful differences in results were only obtained for major project alternatives. CDTC does not expect any additional significant work in "fine-tuning" the marginal costs since current values are viewed as producing reasonable results for the types of decisions that must be made.

In terms of data collection and analysis tools, CDTC will complete their arterial roadway inventory; updates to this inventory will then be incorporated into the ongoing data collection program that is shared by jurisdictions throughout the region. Plans are also being discussed to integrate many of the databases and inventories under a GIS interface; such an interface would also allow better access to land use and demographic information produced by the regional planning commission.

7.0 Contacts and Source Material

For further information on this approach, contact:

John Poorman
Capital District Transportation Committee
5 Computer West Drive
Albany, NY 12205

Several written resources are available regarding Albany's approach, including:

Hirschman, Ira J. and John P. Poorman; *Fixed Guideway Transit Investigation Summary Report*; Capital District Transportation Committee; Albany, NY; July 1995.

Litman, Todd; *Transportation Cost Analysis: Techniques, Estimates and Implications*; Victoria Transport Policy Institute; Victoria, British Columbia, Canada; 1995.

Nelson, Dick and Don Shakow; "Least-Cost Planning: A Tool for Metropolitan Transportation Decision-Making"; in *Transportation Research Record 1499 – Transportation Planning, Management Systems, Public Participation, and Land Use Modeling*; Transportation Research Board; 1995; pp. 19-27.

Poorman, John P.; *Performance Measures in Metropolitan Transportation Planning*; Background paper for presentation at the Conference on Performance Measures for California Transportation System Users and Investors; Sacramento, CA; October 1997.

Poorman, John P.; *Transit Futures Report*; Capital District Transportation Committee; Albany, NY; October 1995.

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Case Study: St. Louis, MO

1.0 Introduction

East-West Gateway Coordinating Council is the designated metropolitan planning organization (MPO) for federal transportation programs for the St. Louis, Missouri region of 2.4 million people. The Council provides transportation planning and analysis in a complex institutional environment, which includes eight counties in two states as well as over 200 municipalities. The agency also serves as a coordinating body for environmental resource planning and community resource planning.

The Council's Board of 21 voting members includes representatives of each county and other chief local elected officials, as well as other representatives of Illinois and Missouri governmental interests. The result is 10 members from each state and one representative of the Bi-State Development Agency (the transit operator). The Departments of Transportation (DOT) of both states are non-voting members.

The Council has been exploring the adoption of performance measures throughout its planning activities for more than four years. The foundation of this effort is the long-range transportation plan, *Transportation Redefined: A Plan for the Region's Future*, adopted in 1994, which emphasizes outcomes of transportation investments in terms of the region's social, economic and environmental vitality. The plan articulates a set of goals and objectives, from which seven focus areas are derived for problem solving with performance measures – both output and outcome – identified for each focus area.

To date, the Council's leadership has sought to use performance measures to implement *Transportation Redefined* in three key areas: a major transportation investment study, the Cross-County Corridor; the annual transportation improvement program covering federally-funded transportation projects; and the analysis of regional freight needs.

The staff reports a high degree of dissatisfaction with the recent process to use measures to rank TIP projects and to assess major corridor investments, and a moderate level of satisfaction with the effort to develop measures to evaluate freight investments. Issues of concern to participants include the large number of measures produced by the process with corresponding data requirements and, most importantly, the lack of buy-in from its Board for use of the measures in decision-making.

Despite the lack of tangible results from these initial efforts, the Council's interest in, and commitment to, the use of measures to improve transportation planning has not wavered, and they are seeking consultant help in developing measures appropriate to ongoing planning work and a process for tailoring measures to particular studies.

This case study will review the three efforts to implement performance-based planning initiated by the long-range plan.

2.0 Experience with Performance-Based Planning

Encouraged by new MPO responsibilities for system management and performance contained in the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), the Council has become more focused on the utility of performance measures for tracking system condition and improvement. Even more important, in the long-range planning effort, the Council redefined transportation's role in the region (hence the title) as a tool for achieving broad regional goals for the future. As stated in *Transportation Redefined* (page 37):

> *"Outcome-based performance" sets the standard by which the transportation system will be evaluated in the implementation of this regional transportation plan. Transportation as redefined, is much more than asphalt, concrete, and steel. It refers to an evolving and dynamic system which links the region's communities to opportunity and which supports the region as a whole in the nation's economy.*

Outcomes in seven focus areas are delineated in the plan, which are to guide project plans and capital programming over the following 20 years. The plan defines performance measures for each area to help direct future decisions, but these measures have not proven acceptable and have been refined and changed through several implementing studies. The focus areas are listed below:

1. Preservation of existing infrastructure;
2. Safety and security in travel;
3. Congestion management;
4. Access to opportunity;
5. Efficient goods movement;
6. Sustainable development; and
7. Resource conservation.

With the adoption of *Transportation Redefined*, the Council is seeking objective methods to evaluate planning alternatives, predict outcomes of various plans, and monitor the results of their implementation. While *Transportation Redefined* lays the groundwork for their efforts to develop a performance-based planning system, the actual implementation of this system is through the planning activities themselves. These efforts include 1) major investment studies (MIS); 2) the Transportation Improvement Program (TIP) project selection; and 3) performance measures report cards for specific plans, such as for freight.

2.1 Major Investment Studies

With the adoption of the Plan, the Council looked toward implementation studies in major corridors. One of these major investment studies (referred to locally as Major Transportation Investment Analyses, or MTIA) attempted to use performance measures to compare and rank various modal investments. As a result of the experience on the "Cross-County Corridor," they have developed a generic MIS that uses measures for problem identification and evaluation of impact.

The generic MIS, which has not yet been applied to an actual corridor, requires the development of an evaluation framework focused on goals and objectives established for the project. Four categories of assessment are anticipated: effectiveness (in accomplishing goals and objectives), cost-effectiveness, financial feasibility, and equity. Performance measures would be developed for each of these areas.

The Council was not satisfied with the attempts to have measures integrated into the Cross-County Corridor. The process produced a list of measures that were not consolidated nor were they directly linked to the project or available data sources. A second attempt to develop a more manageable and relevant list of performance measures for this project also did not meet expectations, but provided a greater understanding of what would be needed for future analysis (MIS). In this case, multiple measures were proposed for each of 11 issue categories related to regional goals, resulting in 50 measures for the study, which included both qualitative and quantitative indicators. Qualitative measures were give numerical rankings of zero to five in order to develop overall scores for each investment strategy under consideration.

The problems the Council encountered in the Cross-County study are common to the development of performance measures for any MIS. The most evident problem is the tendency to have an unmanageable 'dump' of performance measures. This is a symptom of the fact that MISs are large studies that examine many facets of an investment. In this case, the consultants also did not consider the availability of data for the performance measures. The combination of excessive and unusable measures made them impractical as a planning tool.

Another problem with the integration of performance measures into the MIS process is a concern that the use of measures for the MIS came too late in the process. It is important that the issues be defined early in the process of analyzing major transportation needs and investment options in order to develop performance measures that are understood and used by study participants.

2.2 Transportation Improvement Program

The Transportation Improvement Program (TIP) for the St. Louis region includes only federally-funded transportation improvement projects. In 1997, the Council reviewed nearly 700 projects for consideration. Of these, 656 projects were selected for the FY 1998-

2000 TIP. The estimated cost of these projects is expected to be approximately $1.5 billion, of which $1.09 billion are federal funds. The Council's intent in using performance measures for the TIP is to try to make better decisions, justify investments, and assess outcomes, but the results to date have been mixed.

Most project recommendations are submitted to the Council by the Missouri and Illinois DOTs, although local groups sponsor some projects. The Council's Transportation Planning Committee selects projects for recommendation to the Board of Directors. This Committee includes representatives from each county, the local public transit providers, and the Missouri and Illinois DOTs.

The process for selecting projects has been developed to ensure that projects are chosen on the basis of their priority to the region, as indicated by their impact on the goals, objectives, and policies adopted in the long-range plan and subsequent policy processes. Proj??ects are also selected on the basis of their cost-effectiveness. To start, each project that is recommended to the Council is identified with one of the seven focus areas in *Transportation Redefined*. The 'cost-effectiveness' of each project is also measured on a per unit of benefit basis, which is calculated by dividing the level of impact of the project into its annualized cost. Projects are ranked by the combined factors of highest priority and cost-effectiveness. Projects are selected if they fall within the available local, federal, and other funds.

One of the fundamental problems with this application of performance measurement to the TIP process is that, while measures reflect regional priorities, they are not adequate for monitoring progress toward the overall MPO goals. The use of priority areas to determine which projects should be selected is an essential first step in a performance-based system, but a method of actually measuring performance also is needed. For instance, the MPO should collect evaluative data, such as accidents and level of service, in order to measure the actual impact of a project against its expected impact.

According to staff interviews, another problem with this process is that the Council is only receiving requests for projects that the sponsors already know will fit the criteria. This limits the pool of proposed projects to those that are in a few priority areas or are least expensive, and not necessarily meant to address the Council's overall transportation priorities.

■ 2.3 Performance Measures Annual Report Card: Freight

The Council has had more success in recent efforts to establish a performance measurement system for planning in the freight area. The objective of this system is to continually monitor a finite set of freight-related performance measures in order to define and address freight needs. A set of performance measures was developed in a partnership effort with local freight carriers.

Following the experience of New York State DOT, the Council's consultant surveyed the freight industry to identify regional transportation needs and to measure the economic impact of these needs. With the help of industry leaders, the Council identified freight objectives and consulted other resources, including other transportation agencies. As an early step in the analysis, the consultants identified a "Priority Goods Movement Network." Subsequently, six categories of measures were identified reflecting regional freight objectives, and a comprehensive list of 28 possible measures was determined. The categories include:

1. Connectivity/Congestion;
2. Reliability;
3. Intermodal;
4. Safety;
5. Economic/Environmental (External to the Transportation System); and
6. MPO Project Development.

A final set of 19 measures was recommended by the consultant as the "Freight Performance Measures Annual Report Card." Two criteria were used to refine the initial list: the ease of acquiring the needed data and the significance of the indicator to the region.

In the view of the staff, the draft freight performance measurement system is the Council's best attempt to establish a system to date. The stakeholders provided valuable insight into the needs of the system and enabled the agency to take the suggested list of measures in the long-range plan and create usable measures that have significance for both the region's freight industry and the planners. Additionally, the measures are assumed to be more readily implementable due to the emphasis on using indicators which require available data. It is important to point out, however, that the Freight Report Card is under consideration by the Council and has not yet been implemented.

A comparison of the original measures proposed in *Transportation Redefined* for goods movement are shown in Table 2.1, side-by-side with the resulting measures adopted for the freight report card. A review of the table shows that most of the relatively broad measures proposed in the plan were addressed in the final recommendations for the Freight Report Card, generally through one or more specific indicators. For example, in *Transportation Redefined*, one measure for goods movement was "volume of intermodal transfer," which the Freight Report Card incorporates through the measure, "Number of intermodal lifts that occur yearly at local intermodal facilities." Overall, the report card emphasizes safety much more than the plan's proposed measures: one measure in the plan versus seven in the report card. And, the report card does not address the relative costs to shippers and receivers (item 3) or average transfer time from one mode to another (item 11), apparently due to the difficulty in collecting data.

Table 2.1 Measuring Progress in System Performance

Measures Proposed in Plan, 1994	Measures Recommended by 1997 Study
The following measures were included in "Transportation Refined" as a baseline for analyzing the movement of goods in the region and for assessing progress in intermodal freight movement.	The following measures were subsequently recommended for the Freight Report Card:
1. Tonnage of freight moved through the region by mode: • general aviation • truck • rail • pipeline • water	1. Connectivity/Congestion • Average speed on the St. Louis Region roadway network • Truck counts at several key locations on the PGMN[1]
2. Average travel time to move through the region, for modes above	2. Reliability • Level-of-Service below C on PGMN roadways
3. Relative costs of cargo movement to shippers and receivers	3. Intermodal • Tons of Air Freight departing STL • Tons of cargo transported through the port • Number of intermodal lifts that occur yearly at the local intermodal facilities
4. Economic Impacts 5. Accident rate for freight-moving vehicles in the region 6. Ease of access to terminal facilities, buildings, or other structures 7. Ease of movement from one transportation facility to another	4. Safety • Number of at-grade railroad crossings in the Region/or on the PGMN • Number of overpasses in the Region (or on the PGMN) that have vertical clearance restriction • Number of weight restricted bridges in the Region (or on the PGMN) • Intersections with inadequate turning radii for 53' trailers in the Region (or on the PGMN) • High accident locations on the PGMN • Ramp geometry where site distance to poor or sharp turns are required • Pavement life remaining on PGMN routes

[1] PGMN refers to Priority Goods Movement Network

Table 2.1 Measuring Progress in System Performance (continued)

Measures Proposed in Plan, 1994	Measures Recommended by 1997 Study
8. Miles of local streets used to provide access to rail, port, and intermodal facilities 9. Number of operational facilities for the transfer of freight from one mode to another 10. Ease of access to intermodal transfer facilities	5. Economic/Environmental • Value of the freight that is moved from, to and within the region to develop an overall (direct, indirect and induced) economic impact • Number of people employed in five or so major economic sectors in the St. Louis Region • Amount of warehouse space available in the St. Louis region and Current Occupancy Rate of the warehouse space
11. Average time to transfer from one mode to another 12. Volume of intermodal transfer	6. MPO Project Development • Traffic signal synchronization along key corridors (Determined by corridor delay, congestion) • Amount of intermodal capacity predicted for future years (five-year horizon) • A measure of the ability to expand existing operations at ports, intermodal facilities, production facilities, etc.

3.0 Experiences/Lessons Learned

A key issue in adopting performance-based planning in St. Louis has been getting agreement among the various interests to focus on a few, good measures. *Transportation Redefined* identifies over 20 measures for each of the seven focus areas. The Cross-County analysis incorporates multiple measures for each of 11 categories. However, for the Freight Performance Measures Annual Report Card, only 19 measures have been proposed for implementation. Interestingly, the latter process has been deemed to have the most potential of the three efforts to develop a performance-based system. According to the Council's executive director, presentation of so many measures serves to confuse as much as to inform and has not helped the decision-makers.

This multiple measure situation also leads to a third problem: an overwhelming data collection requirement. Like other transportation agencies, the Council also has had difficulty with the availability of appropriate and adequate data required by even a limited set of measures. Consequently monitoring becomes difficult and impractical.

The recent experience of the Council, especially the last two years, has made the agency more aware of the complexities involved in developing a performance-based planning system, including the issues described above. They recognize the importance of involving all stakeholders in the development process. In the case of the planning process for the Council, this includes all staff, the Board, and all customers including representatives of both public and private interests. In particular, it is critical to have internal support for the system in order to secure its development. It is evident in our discussions with Council staff and with staff of sister agencies in the region that support for performance-based planning is present, but some with whom we met did not understand all the requirements for development and implementation of a performance-based system. The tendency in the earlier study efforts (TIP and Cross County) to propose multiple measures that may not have readily available data to support their use appears to be a symptom of staff enthusiasm for the potential information such measures would provide, without a corresponding awareness of the commitment of resources required to implement such an extensive system.

Finally, our interviews indicated a need for enhanced in-house capacity to develop and use their performance-based planning system. Within the context of an organization-wide approach to transportation planning, it appears that the use of performance measures should be implemented in only a few programs at a time in order to ensure quality and to allow for the development of in-house capacity.

4.0 Applicable Source Materials

East-West Gateway Coordinating Council, *Transportation Improvement Program, Fiscal Years 1998 through 2000*, July 1997.

East-West Gateway Coordinating Council, *Freight Performance Measures Annual Report* Card (draft), August 1997.

East-West Gateway Coordinating Council, *Generic Scope of Services for Conducting Major Transportation Investment Analysis (draft),* May 1997.

East-West Gateway Coordinating Council, *Transportation Redefined, A Plan for the Region's Future*, May 1994.

East-West Gateway Coordinating Council, *Cross-County MetroLink Strategic Alignment Analysis, Draft Report*, August 15, 1997

U.S. Department of Transportation, *Enhanced Planning Review of the St. Louis Metropolitan Area*, June 1996.

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Case Study: Twin Cities

1.0 Introduction

The Metropolitan Council of the Twin Cities (Met Council) is the designated metropolitan planning organization (MPO) for the seven-county urbanized region that encompasses the Twin Cities of Minneapolis and St. Paul, Minnesota. This is an area of about 2.5 million people, the great majority of which (over 1.5 million) reside in the two counties surrounding Minneapolis (Hennepin County) and St. Paul (Ramsey). While the two core cities of the region maintain a distinctly urban character, with expansive skylines and vibrant neighborhoods, the region as a whole is of moderate to low density, with the outer portions retaining a rural character in what have historically been agricultural or vacation areas. The region has enjoyed steady growth throughout the past 15 years, rivaling high-growth western areas like Dallas, Seattle, and Denver, but clearly outpacing most of its peers in the eastern US. However, despite a 16.2 percent increase in regional population between 1985 and 1995, the two primary urban counties, Hennepin and Ramsey, realized only a 6.7 percent population gain, while the remaining five counties grew by 37.3 percent. Also, the 12 Minnesota counties that surround the Metro region and which are regarded as its "commuting area," grew substantially in population, 19.4 percent, and jobs, 31.6 percent, during this same period. Anticipated growth over the next 20 years is expected to mirror the historical trends, presenting the region with some major unanswered questions as to how future transportation mobility and financial needs will be met.

The Twin Cities is generally regarded as one of the nation's more proactive and progressive areas in its attention to planning issues. Back in 1980, the Met Council conducted a comprehensive transportation system performance audit, which grappled with multimodal performance and mobility issues a good 10 years before ISTEA was enacted and brought such concepts to the attention of the nation's MPOs and state DOTs. The region has always had an active and open process for engaging the public in its planning and decision-making, and the Council has served as a forum for airing and resolving complex issues on regional investment and growth management. The Minnesota Department of Transportation (Mn/DOT), whose authority is principally linked to the region's principal highway system, is also generally regarded as one of the nation's more progressive DOTs. Mn/DOT has not only maintained its extensive system of trunk highways at a high level of condition, despite Minnesota's severe winters, but also has been a leader in planning and system innovations. The seven-county metro region has an extensive 187 lane-mile system of metered highways, designed to manage use and maximize performance of the region's primary system. This system is complemented by such features as high occupancy vehicle lanes, ramp meter bypasses for HOVs, and traffic monitoring and traveler information systems. Mn/DOT has been a leader in investigating Intelligent Transportation Systems technology applications under its "Guidestar" program, and is also pursuing a commercial vehicle operations (CVO) management system to make maximum use of advanced technology to manage growing truck volumes on regional highways. Mn/DOT's planning research division has been equally on the leading edge in its planning concepts, introducing the Family of Measures framework in the mid-1990s as a means for measuring the performance of the highway system in supporting mobility and other regional goals.

2.0 Impetus for Performance-Based Planning

Despite the Met Council's reputation for progressive planning and earlier pioneering efforts with performance measures and evaluation, the context for this particular case study profile stems from an external action imposed by the Minnesota state legislature for a transportation system audit. In a statute enacted in 1996, the legislature directed the Met Council to conduct a comprehensive audit of the region's transportation system and its ability to meet the "commuting area's" needs for effective and efficient transportation of goods and people. As part of the audit, the Met Council was also asked to evaluate future trends and their impact on the transportation system, and make recommendations for improving the system. The audit was also required to recommend "performance funding measures." The first audit was to be conducted in 1997, and then again every four years, with a specific audit of the region's transit system's performance in relation to adopted performance standards every two years.

Interestingly, the requirement for the audit came at the time that a series of major policy/strategic planning studies were underway in the region by the Met Council, Mn/DOT, and Metro Transit. These studies and plans were in the process of addressing many of the economic, demographic, transportation and mobility issues that were raised by the audit requirement. The timing of the audit, therefore, naturally raised questions as to the legislature's intent, given that these major planning activities were underway. A quick overview of these strategic studies is useful.

■ 2.1 Met Council's Regional Blueprint and Transportation Policy Plan

In late 1996, the Met Council completed two interrelated policy planning efforts: The ***Regional Blueprint***, a comprehensive expression of the Council's vision for the region's future, and a ***Transportation Policy Plan*** which set forth specific strategies to implement the transportation elements of the Blueprint. The ***Regional Blueprint***, which was developed by the Council as a whole, articulated long-range goals and objectives that encompassed all regional systems, not just transportation, although transportation was clearly a major element under many of the themes. The December 1966 Blueprint made it plain that the region's priorities were to:

- Make investments and pursue policies that would continue to strengthen the region's economy;
- Direct investments to the renewal of declining or distressed areas;

- Build strong, livable communities;
- Protect the environment; and
- Manage the region's growth.

Also in December 1996, the Council staff completed its ***Transportation Policy Plan***, which set forth 16 specific transportation-related policy objectives, along with strategies for their attainment. These objectives were as follows:

1. Focus transportation investments on support of economic and quality of life objectives, and in support of the adopted regional growth policy;
2. Ensure adequate financial resources to meet regional transportation needs;
3. Prioritize investments toward preservation of existing assets;
4. Maximize public awareness and participation in the planning process;
5. Build transit-exclusive facilities to ensure future service that will be competitive with the automobile;
6. Tailor transit services to most effectively serve their distinct markets;
7. Promote competition and variety in transit service offerings;
8. Increase the attractiveness and friendliness of transit service;
9. Provide improved access for the disabled;
10. Manage the growth in travel demand;
11. Plan and manage the highway system to ensure maximum sustainable service;
12. Ensure a competitive, interconnected regional freight system;
13. Build & maintain an effective bicycle and pedestrian network;
14. Preserve future corridor rights of way;
15. Manage the environment; and
16. Manage land use through better comprehensive planning.

2.2 Mn/DOT's Transportation System Plan

In January 1997, Mn/DOT's Metro Division, the Mn/DOT district which manages the highway system in the seven-county region, released its ***Transportation System Plan*** for maintaining and improving its trunk highway system from 2001 to 2020. The purpose of the TSP was to document long-range planning decisions and to make those decisions more systematically in relation to projected funding constraints. The TSP was not mandated by federal or state statutes, but was developed explicitly in conjunction with Mn/DOT's Statewide Plan (STP) and the Met Council's Transportation Policy Plan (TPP) to fill the gap between the long-range 20-year policy guidelines of the STP and the TPP, and the short-range improvements included in the three-year Transportation Improvement Program (TIP).

The objectives of the ***Transportation System Plan*** were to:

- Reinforce land use/transportation relationships;
- Ensure that highway system actions are cost-effective, and address financial stability goals;
- Prioritize investments that service multiple objectives and modes; and
- Prioritize investments that improve mobility and continuity.

Linked to these general policy objectives, the ***Transportation System Plan*** also issued a set of financing guidelines and priorities for projects. The highest funding priority was assigned to the preservation of the existing system. The second priority was to manage the existing system to its highest efficiency. The third-level priority was to focus capital investments on removing system deficiencies, and the lowest priority was assigned to the expansion of capacity. An important concern underlying the TSP was Mn/DOT's estimation of $10 billion in financial needs to properly maintain the existing system *and* to maintain mobility at current levels through 2020, while foreseeing only $3.4 billion in funds. Given that system preservation receives top funding priority, followed by management and safety, only $0.635 billion would be available to address demand for new capacity over this period, during which time VMT is expected to increase by 38 percent.

2.3 Transit Redesign

A third major transportation policy-defining activity which occurred during this period was the ***Transit Redesign*** study, performed by the Metropolitan Council to address those issues concerning public transit's future role in the region. Whereas the metropolitan region had been growing steadily over the 1985-1995 decade, transit ridership both as a percentage of total travel and in terms of absolute ridership had been steadily declining. Metro Transit, the major transit service provider in the region, had experienced a decline of about 1.5 million annual passengers from 1985 to 1995. Simultaneously, transit service provision in the region had been gradually taking new forms, with many of the outlying areas of the region opting out of the regional service agreement with Metro Transit in favor of providing their own services. In light of these changes in market conditions, institutional organization and performance, the ***Transit Redesign*** study was conducted to appraise the situation for transit and identify strategies to clarify its role and maximize its performance. The product of the study was a set of goals and objectives, coupled with specific actions and strategies, to direct Metro Transit in providing the best possible service in this changing marketplace. The essence of these strategic directions were to:

1. Redesign and diversify the delivery of transit services to more effectively serve the needs and characteristics;

2. Make transit service more cost-efficient, increase competition and decentralize the decision-making process;

3. Make transit service more competitive with the automobile through multimodal investment, design, pricing and financing strategies; and

4. Encourage more pedestrian and transit friendly community designs.

As a way of ensuring focus on and adherence to these objectives in future plans and programs, ***Transit Redesign*** also established a set of performance measures and standards through which to monitor and evaluate future progress. The two key measures adopted were Passengers per Revenue Hour to establish a minimum threshold for big bus service, and Subsidy per Passenger as a threshold for public cost exposure, with differences by type of service.

3.0 Process

Given the nature of the audit as an externally-imposed requirement, the Met Council was further obliged to select an outside party to perform the audit. Specifically, the Council was directed to select an independent entity, selected through a nationwide request for proposal process, to conduct the audit. This process resulted in the selection of a contract team headed by Cambridge Systematics, and including SRF Consulting Group of Minneapolis, and several national and local transit, freight, and performance measurement specialists.

The contract audit team worked closely with and reported to a Management Team comprised of representatives of the Met Council, Mn/DOT, Metro Transit, and the Council Board. The process consisted of initial joint sessions during which key issues and data resources were related to the study team, followed by development of a framework for conducting the evaluation, specification of measures, and conduct of the analysis.

The entire audit consumed about seven months, beginning in June 1997 and concluding with a draft final report in December. The steps in this process and the time consumed by each step are summarized below:

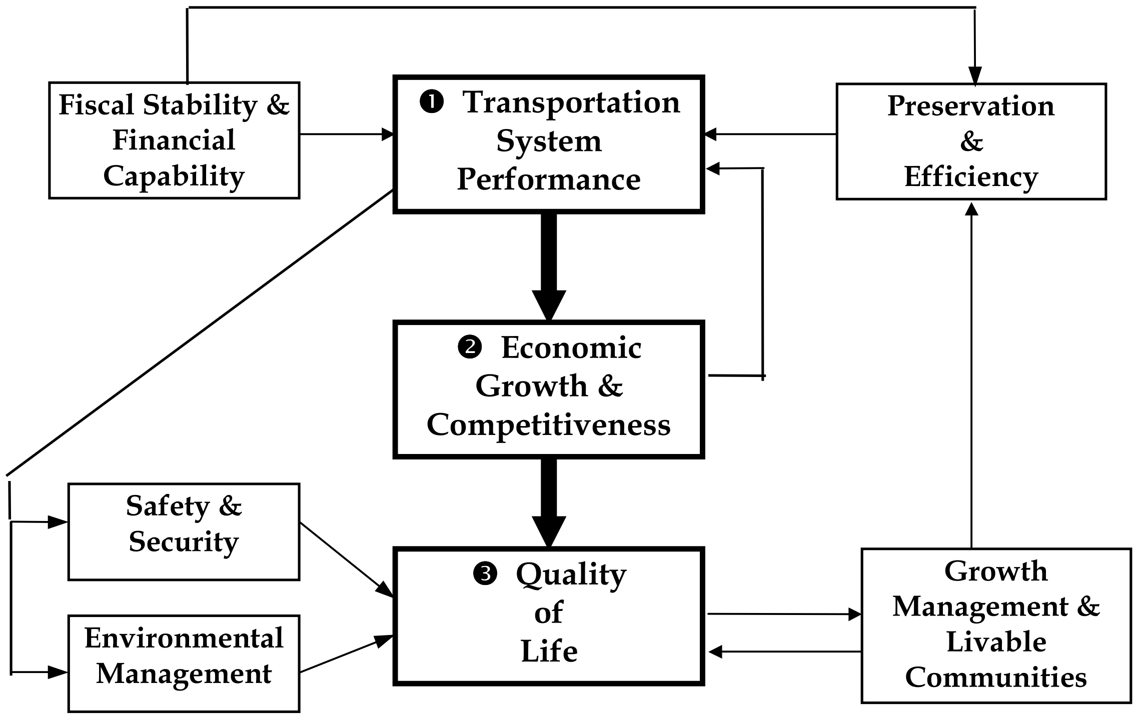
1. Development of background and consensus on key issues, sectors, performance measure principles, and initial identification and assessment of prior related studies and data resources (one month).

2. Development of a framework to clarify understanding of key transportation, economic and quality of life interrelationships, and to identify the context in which performance measures would be specified and evaluation conducted (one month). The following framework (see Figure 3.1) was adopted.

3. For each of the areas of interest represented by a box in the framework, a set of specific issues was defined, a measurement hypothesis and analysis proposed, and then specific performance measures were proposed. These concepts were methodically discussed with members of the Management Team, and their input was reflected (one month).

4. Data sources and model capabilities were investigated to ascertain which of the various measures could be developed with current data or model tools, and/or the form that the measure would have to take in accord with the data capabilities. Also, sources of information for external comparisons were also identified. A formal list of measures was developed, linked with the anticipated data sources, and the proposed analyses method (time trend vs. benchmark, peer comparison, etc.). This product was presented to the Management Team, and priorities (high, medium or low) were assigned to each measure in an attempt to reduce the list to a manageable size for which data were available (one month).

Figure 3.1 Framework



5. The study team embarked on an intensive period of data acquisition, model runs, and file development to support the development of the identified measures and enable the audit to be performed (six weeks).

6. A preliminary audit report was prepared, in which data from Step 5 were reduced, compiled, and formatted in a manner as to address the given measure. Simple compendiums of tables of information supported by brief descriptions of what findings were (or were not) evident in the data were compiled into individual three-ring binders by major topic area, and circulated among the Management Team members for appraisal, and as a departure point for selecting those key measures and relationships to be highlighted in the official audit report (six weeks).

7. Upon review of the draft findings in Step 6, a final audit report was developed that captured the following themes (one month):

   - The issues behind the audit;
   - The geographic and demographic features and past trends that shaped the region;
   - The elements of the region's transportation system (highway, transit, and freight/intermodal), their extent, and physical condition;

- The performance of the transportation system in meeting specified goals and objectives measured in relation to effectiveness, efficiency, and externalities;
- An appraisal of the transportation system's impact on social and economic goals, such as economic growth and competitiveness, standard of living, and quality of life;
- User satisfaction, as assessed through surveys with residents, businesses, and transportation system users;
- An assessment of the transportation system's financial performance and funding needs;
- A projection of future trends in population and economic growth and their impacts on travel demand and the quality of travel, leading to an assessment of funding needs; and
- Identification of Performance Funding Measures to be used to guide decision-making on resource allocation for future investments.

4.0 Performance-Based Planning System

It is too early to tell where the Met Council and the region will go with performance planning concepts. The introduction to this process which has occurred through the audit has had some mixed results. First, this initial audit has been a very intensive exercise in terms of staff involvement in data identification, coordination, and review and guidance. Added to this has been the cost of retaining an outside entity to perform the audit, and the various uncertainties that have been raised by some of the data and analyses, both in unfamiliar areas (e.g., freight) and in familiar (e.g., unexpected or counterintuitive results from transportation models). At a pragmatic level, it must be acknowledged that conduct of such a thorough audit process, particularly when it is imposed from an external source that has funding authority over the performing agency, can be intimidating to the agency. Facts can surface that were not expected, that may be distorted based on the quality of the data used, or may be wrongly interpreted in the hands of the lay user. Yet at the same time, the Council is seeing considerable potential value in the data, the measures, and the systems which have been compiled by the audit. The audit has greatly increased their understanding of their region, subsystems that they were not familiar with or focused on, and where trends have taken them and will be taking them. Properly used, the information assembled in the 1997 audit can provide many benefits in future planning or reporting activities that the Council is drawn into.

5.0 Impact of Performance-Based Planning on the Organization

Since the audit has only recently been completed, more attention has been given to completing the audit responsibly and according to the legislature's schedule, than on what the audit is really telling the region or in how it may change the way in which it may change the way they do business. Some findings that came out of the audit that may not have otherwise come to the attention of the region's leaders are:

- That rapid suburbanization over the past decade has been evident in the rate of growth in vehicle travel demand and traffic congestion. The rate of growth in congestion in the Twin Cities was found to be the highest of all metropolitan areas in its size-based peer group, and fifth among all major U.S. urban areas.
- That continued suburban and exurban/rural growth trends will result in major increases in regional VMT (38 percent) over the next 20 years, increases which are currently not slated to be met by any significant new investments in highways. Left unabated, these trends are pointing to a mobility crisis in future years. In particular, the growth in traffic is likely to have very significant effects on the secondary road system, where spillover from crowded expressways and arterials will cause congestion, accidents, and neighborhood livability concerns that are not presently felt.
- Transit in the region has been on a steady decline, having lost two million annual passengers between 1985 and 1995. By national peer standards, Metro Transit has made impressive efforts to maximize efficiency and control costs, even to the extent of putting a heavier cost burden on its users through fares which are high by industry standards. However, state and local funding for transit is among the lowest in the industry, on either a per capita or per rider basis, indicating that the region has effectively disinvested in transit.
- Regional growth management objectives call for limiting additional expansions into rural lands, and attempting to magnet growth and development instead into existing nodes and corridors. However, the audit found that these objectives were not evident in the growth trends, and were not consistent with the investment patterns in highways and transit. A major recommendation of the audit was to target investments in areas where the most people could be served through optimal land use relationships and multimodal capacity.
- The rate of growth in heavy truck traffic on regional highways was lower than that of regular vehicles over the last 10 years, but still increased 44.5 percent over 1985 levels, amounting to an additional 230 million annual VMT on trunk highways alone. This travel segment is not being strategically or formally planned for, and is likely to have a major effect on future system capacity needs, system performance and wear rates, and ultimately on regional access and mobility levels that are critical to businesses and residents.

- Rapid growth in counties surrounding and outside the seven-county region has had and will continue to have a major impact on the use and remaining capacity of the regional highway system. In 1990, commute trips by non-residents consumed and estimated 31 percent of the available capacity on metro highways, and by 1995, the rate had increased to 38 percent. Future development is expected to result in non-resident commuters using 63 percent of the available capacity by 2020.

6.0 Lessons Learned and Future Plans

Because of the statutory requirements imposed on the Met Council by the state legislature, from a pro forma perspective the Council is now obliged to conduct a full system performance audit every four years, to conduct a detailed transit system audit every two years, and to gradually adopt the concept of performance funding measures into their planning and decision-making. To adhere to this requirement, it will be necessary for the Council to continuously monitor performance through key indicators, and collect data that will be necessary to report on progress in subsequent audit. This does not seem to be a task that the Council will necessarily find objectionable, since they too have desired to put in place an effective performance monitoring and reporting process, and the audit has simply served to accelerate implementation of this objective.

7.0 Source Materials

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Case Study: Florida DOT

1.0 Introduction

The case study of the Florida Department of Transportation (FDOT) provides an opportunity to view the process of monitoring, evaluation and feedback as incorporated in the management and planning of Florida's transportation system. The Florida has developed an experience base that can help the profession to refine and reshape the tools of evaluation and feedback used in the process. While the Florida planning team enthusiastically supported the concept of monitoring evaluation and feedback, they placed into sharp question the present orthodoxy that suggests that the measures can be defined in terms of simple ratios or formulas.

In Florida, the tradition of accountability is well established in both law and practice. The *Commission on Accountability to the People* had established the principles of monitoring program performance, and establishing accountability before the passage of ISTEA. The pro??cess of *monitoring* and *feedback* is established in the long-range and short-range components of the *Florida Transportation Plan* (FTP), and throughout the planning and project development process.

2.0 The Long-Range Component: Commitment to Monitoring and Feedback

The FTP has two components, the *long-range* component that identifies goals and objectives for the next 20 to 25 years, and the *short-range* component that identifies key objectives and strategies for the next one to 10 years. The commitment to a program of monitoring and feedback is stated clearly in the FTP, providing for a case study concerning both the strengths and weaknesses of this approach. This document makes it clear to the citizen that four key concerns will dominate the nature of allocation decisions in Florida, which are stated as the four long-term goals included in Table 2.1.

The FTP includes one of the strongest and most clear-cut commitments to a program of monitoring and evaluation of any similar state or metropolitan planning document. The plan promises that:

> *Data and strategies from the management and monitoring systems (such as pavement and bridge conditions on state highways, safety issues, congestion levels and strategies to address them, etc.), measures of performance from those systems and other sources, changes in law and emerging issues will be key elements in revising or extending state transportation goals and objectives in the future years.*

Further, the same document commits to a process of monitoring and evaluation of the results of the interventions in the system that is based on the concepts of monitoring, evaluation and feedback.

> *Indicators of progress have been created to demonstrate how the Department will measure progress towards each long-range objective. These indicators state what we will monitor during this timeframe, such as the rate of motor vehicle crashes to gauge progress made toward our objective. If our monitoring system indicated that reduction in crashes was not achieved, this will be reflected along with the suspected reason in the annual performance report. Similarly reductions will also be reported. Subsequent versions of this plan will begin the process of turning the indicators of progress into measurable short-range objectives, where appropriate, and will recommend any necessary changes to help better achieve the objective.*

Table 2.1 Relationship of Goals and Objectives in Florida's 2020 Plan (1995)

The Four Goals of the Long-Range Plan			
Safe transportation for residents, visitors and commerce	Protection of the public's investment in transportation	A statewide interconnected transportation system that enhances Florida's economic competitiveness	Travel choices to ensure mobility, sustain the quality of the environment, preserve community values and reduce energy consumption
The Objectives to Serve the Goals of the Long-Range Plan			
Reduce the rate of motor vehicle crashes, fatalities and injuries and bicycle and pedestrian fatalities and injuries on the highway	Preserve the state highway system	Place priority on completing the Florida Intrastate System	Reduce dependency on the single-occupancy vehicle
Improve intermodal safety where modes intersect, such as highways or railroad bridges over waterways and highway-railroad crossings	Reduce the number of commercial vehicles that exceed legal weight limits on the state highway system	Complete a Statewide High-Speed Rail System	Provide accommodations for transit vehicles, bicyclists and pedestrians wherever appropriate on state highways
Improve the safety of commercial vehicles, rail facilities, pubic transportation vehicles and facilities and airports	Protect the public investment in aviation, transit and rail facilities	Improve Major Airports seaports railroads and truck facilities to strengthen Florida's position in the global economy	Increase public transportation ridership
Improve emergency preparedness and response		Improve connections between seaports, airports, railroads and the highway system for efficient inter-regional movement of people and goods	Expand public and specialized transportation programs to meet the needs of the transportation disadvantaged
		Manage and preserve designated transportation corridors in cooperation with local governments and through advance acquisition of right of way	Minimize the impact of transportation facilities and services on the environment
			Increase energy conservation and use of recycled materials, native vegetation and wildflowers

3.0 The Short-Range Component: Indicators in Support of the Short-Term Objectives

Florida is committed to producing an *annual* performance report, presenting a status report of developments relative to 15 *short-range* objectives. Trends and conditions are gathered, and presented in the report that identifies key objectives and strategies for the next one to 10 years that are necessary to implement the goals and objectives identified in the long-range component.

The NCHRP 8-32(2) research is examining a process in which the desired effect of a public policy is specified at the time of the adoption of the policy, with a commitment to track the issue over time with measures which are specified early in the process. Florida's 15 short-range objectives represent an excellent application of this principle. Most of the 15 objectives are presented in a graphic format, along with a key indicator of how the monitored measure is performing. This creates the annual performance report promised in the Long-Range Component of the FTP.

The Short-Range Component of the FTP emphasizes the concept of key indicators that provide data useful to the analyst who is examining the performance of the system, or the performance of the agency. It should be noted at this point that the Short-Range Component does not use the phrase "performance measures" to describe the indicators presented. This concept will be explored in the Section 7.0 of this case study.

■ 3.1 Analysis of the Measures

Tables 3.1 through 3.4, bring together the *Strategic Issues, Key Indicators, Short-Range Objectives*, and *Budget Program Measures* which actually appear in different chapters in the 1998 Short-Range Component of the FTP. The existence of the four kinds of data (as expressed in the four columns in the tables) provides a lucid demonstration of the many kinds of information expressed under the more general concept of monitoring the system. As noted above, the phrase "performance measures" is not used to describe the content of any of the categories.

Table 3.1 Short-Range Component – Goal Number One "Safe Transportation for Residents, Visitors and Commerce"

Strategic Issue	Key Indicators	Short-Range Objective	Budget Program Measures
Reducing fatalities on Florida's roads	• Highway fatalities	By 2006, reduce the highway facility rate to, or below the national average	• Motor vehicle fatalities per 100 million miles traveled
	• Florida highway fatality rate		• Bicycle and pedestrian deaths per 100,000 population
	• U.S. highway fatality rate • Rural highway fatalities • Urban highway fatalities • Pedestrian fatality rate • Bicycle fatality rate		
Minimize road-related conditions that contribute to crashes	• Total number of crashes on the state highway system	Through 2006, keep the percentage of crashes on the state highway system where road-related conditions are listed as a contributing factor to below one percent	• Percentage of vehicle crashes on the state highway system when road-related conditions were listed as a contributing factor
	• Total number of state highway system crashes where road-related conditions are listed as a contributing factor		• Percent of commercial motor vehicles that pass safety inspection
	• Percentage of total crashes on the state highway system where road-related conditions are listed as a contributing factor		• Number of commercial safety inspections performed

Table 3.2 Short-Range Component – Goal Number 2 Preserving the System: Protection of the Public's Investment in Transportation

Strategic Issue	Key Indicators	Short-Range Objective	Budget Program Measures
Continuing to meet department standards for pavement condition	• Total percentage of state highway system pavement meeting department standards • Percent of turnpike pavement meeting department standards • Percent of Florida intrastate highway system meeting department standards • Percent of non intra-state state highway system pavement meeting department standards	Through fiscal year 2006, ensure that 80% of pavement on the state highway system meets department standards	• Percentage of state highway system pavement in good condition • Number of lane miles let to contract for resurfacing • Number of commercial vehicle weighed • Percent of commercial vehicles weighed that were overweight • Number of portable scale weighing performed
Continuing to meet department standards for bridges	• Percent of FDOT-maintained bridges meeting department standards • Percent of locally maintained bridges that do not need major structural repairs	Through 2006, ensure that 90% of FDOT-maintained bridges meet department standards, while keeping all FDOT-maintained bridges open to the public safe.	• Percentage of state maintained bridges in good condition • Number of bridges let to contract for repair • Number of bridges let to contract for replacement
Continuing to meet department standards for roadway maintenance	• Percentage of maintenance standard achieved for roads on the state highway system	Through Fiscal Year 2006, achieved 100% of the acceptable maintenance standard on the state highway system	• Maintenance condition of state highway system as measured against the department's maintenance manual standards • Tons of asphalt placed by maintenance crews

Table 3.3 Short-Range Component – Goal Number 3 Economic Competitiveness

Strategic Issue	Key Indicators	Short-Range Objective	Budget Program Measures
Placing priority on the Florida Intrastate Highway System. NOTE: additional work now underway showing (how to measure the outcome of placing priority on completing the FIHS)	• Funds committed for capacity improvements on the FIHS as a percentage of the Highway Capacity Improvement Program	Through 2006, maintain funds committed for capacity improvements on the FIHS at approximately 50% of the highway capacity improvement program.	• Number of lane miles let to contract for highway capacity improvements
	• Average daily vehicle miles traveled per land on the FIHS		• Number of right of way parcels acquired • Number of projects certified for construction
	• The two proposed systemwide measures are: 1) person miles of travel and 2) average speed of travel • The department is working on an interim performance measure that better addresses mobility on the FIHS, not expenditure	By 2006, begin to maintain mobility on the FIHS by accommodating the growth in demand for moving people and goods.	
Improving connections between transportation facilities	• Passenger enplanements	Through 2006, continue to improve intermodal connections and access by annually allotting approximately $30 million in state funds for the intermodal access program. NOTE: additional objective to be added later that will set a target for system performance	• Number of passenger enplanements
	• Cargo shipped by air		• Tons of cargo shipped by air

Table 3.3 Short-Range Component - Goal Number 3 Economic Competitiveness (continued)

Strategic Issue	Key Indicators	Short-Range Objective	Budget Program Measures
	• Rail cargo originating or terminating on the Florida rail system		• Number of rail proj??ects funded
	• Total waterborne trade		• Total waterborne trade in tons
	• Cruise embarkations		• Number of cruise embarkations at Florida ports
	• Aviation project funding – state aid		• Number of aviation projects funded
	• Level of investment in the intermodal access program		• Number of intermodal projects funded
Completing a statewide high-speed rail system	• Not defined	By 2006, begin high-speed rail service between Miami and Orlando, and Orlando and Tampa	

Table 3.4 Short-Range Component – Goal Number 4 Supporting Florida's Communities Travel Choices to Ensure Mobility, Sustain the Quality of the Environment, Preserve Community Values and Reduce Energy Consumption

Strategic Issue	Key Indicators	Short-Range Objectives	Budget Program Measures
Delivering the work program	Percent of work program project phases which experienced no changes in schedule or were advanced to an earlier year	Implement the priorities of metropolitan planning organizations and local governments by annually maintaining or advancing the schedule of at least 80% of project phases in the Departments adopted work program.	Percentage of increase in final amount paid for completed construction contracts over original contract amount
	Percent of construction projects planned for letting that were actually let		Percentage of construction contracts planned for letting that were actually let
	Percent of projects certified ready for construction		Percentage increase in number of days required for completed construction contracts over original contract days
	Percent of difference between original contracts amount and final amount paid for construction projects		
	Percent of increase from original contracts time to actual project time for construction projects		
Decreasing dependency on Single-Occupant Vehicles	Public transit passenger trips	Through 2006, increase transit ridership at twice the average rate of population growth	Number of capital proj??ects funded
	Transit growth rate compared to population growth rate		Number of transit operating projects funded
	Percent of work trips in single-occupant vehicles		Number of public transit passenger trips
	Employees statewide in carpools		Transit ridership compared to population growth

Table 3.4 Short-Range Component – Goal Number 4 Supporting Florida's Communities Travel Choices to Ensure Mobility, Sustain the Quality of the Environment, Preserve Community Values and Reduce Energy Consumption (continued)

Strategic Issue	Key Indicators	Short-Range Objectives	Budget Program Measures
Maintaining Air Quality Standards	Percent of the state the meets national air quality standards Number of counties that experienced isolated exceedances of air quality standards Percent of the state that meets transportation conformity requirement	Through 2006, ensure that all air quality standards related to mobile source emissions are met.	

Within the four columns, several observations can be noted; in some cases, the agency is reporting of *the efficiency of its management operations*; in some cases the agency is reporting the volume of *output produced by the agency*. In some cases, the agency is stating its intention to create measures which describe *the outcome of its policies and actions:* in some cases the agency is reporting *indicators* which are of value to the analysis of program effectiveness, but are not described by the agency as performance measures. In Tables 3.5 through 3.9, elements of the monitoring process have been organized into these four categories.

Based on the early work of the Commission on Accountability to the Public, and the ongoing work of the state Transportation Commission, much of the initial work on the measurement of performance concerned the *efficiency of management*, rather than the output or even the outcomes of the agency's actions. Largely based on this experience, the interest grew in more effectively monitoring the output of the agency. "You should do something to measure what you are spending, and what they are getting," commented one official on the appropriateness of outputs.

Within Florida's comprehensive program of tracking and monitoring its own operations, one of the most important categories is the tracking of agency output. The monitoring of output is a key element in the total program of monitoring and evaluation of the agency's performance. Importantly, the Florida staff sees the monitoring of actual output as more feasible than measuring the second and third order impacts of investment (generally described as *outcomes)*.

While the actual output, (e.g., the number of bridges rebuilt) is the most directly monitorable aspect of performance measurement, the agency also tracks certain indicators which describe phenomena which may or may not be the direct result of agency actions. By way of example, the agency may have a near-perfect record of rebuilding bridges, but the day after a hurricane, many may be out of service. The percentage of roadways in good order, in this case, would be an indicator of how well the agency is performing, but not a linear documentation of output.

In addition to the monitoring of the volume of projects and dollars placed on the street as result of public policy, there is also the question of the impact of those investments in terms of societally-defined goals that are carefully reflected in the transportation plan. The FDOT team noted that while process of monitoring outcomes is appropriate to serve the public policy being examined, it has to be emphasized how difficult it is in many cases to track and monitor the indirect consequences of public policy actions; specifically, to know whether any given result was impacted by the policies and action of the agency, or by other factors entirely independent of the actions of the agency. In some cases, (Table 3.8) the outcomes themselves are tracked; in other cases (Table 3.9) indicators are used to track patterns that may, or may not, be directly attributable to the actions of the agency. Examples of the attempts by the FDOT to monitor results of their own actions are listed in Table 3.8.

Table 3.5 Examples of Measures of the Efficiency of Management

For Goal 4	Percent of increase in final amount paid for completed construction contracts over the original contract amount
	Percentage of construction contracts planned for letting that were actually let
	Percentage increase in number of days required for completed construction contraction over original contract days

Table 3.6 Examples of Measures of Agency Output

For Goal 1	Number of safety inspections performed Number of commercial vehicles weighed Number of portable scale weighing performed
For Goal 2	Number of bridges let to contract for repair Number of bridges let to contract for replacement Number of tons of asphalt placed by maintenance crews
For Goal 3	Number of lane miles let to contract for highway capacity improvement Number of right of way parcels acquired Number of projects certified for construction Number of aviation projects funded Number of rail projects funded Number of intermodal projects funded
For Goal 4	Number of transit capital projects funded Number of transit operating projects funded

Table 3.7 Examples of Indicators Useful in Larger Efforts to Track Agency Output

For Goal 2	Percentage of state highway system pavement meeting department standard Percentage of state bridges meeting department standards Maintenance condition of state highway system
For Goal 3	Did 50% of highway capacity increase budget go to FIHS? Did $30 million for the intermodal access program? Did high-speed rail service begin?
For Goal 4	Did agency produce at least 80% of MPO adopted programs?

Table 3.8 Examples of Outcomes Included in the Short-Range Component

For Goal 1	Keep percentage of crashes on state system attributed to road conditions below 1%
For Goal 2	None. (By our definition, the tracking of investment in the highway system is the tracking of the output of the agency.)
For Goal 3	Begin to maintain mobility on the FHS by accommodating the growth in demand for moving people and goods
For Goal 4	Increase transit ridership at twice the average rate of population growth ensure that all air quality standards created to mobile source emissions are met

Table 3.9 Examples of Indicators Useful in Larger Efforts to Track Outcomes of Policies

For Goal 1	Florida highway fatality rate U.S. highway fatality rate Rural highway fatalities Urban highway fatalities Pedestrian fatality rate Bicycle fatality rate Number of crashes where road created conditions are listed as a contributing factor
For Goal 2	None
For Goal 3	A mobility measure will be created which incorporates person miles of travel and average speed Passenger enplanements Cargo shipped by air Rail cargo Waterborne trade Cruise embarkations
For Goal 4	Percent of work trips in single-occupant vehicles Employees statewide in carpools Transit ridership Percent of the state that meets air quality standards Number of counties that experienced isolated exceedances of air quality standards

The need to move toward measurement of outcomes is noted in the introduction to the short-range component:

> *While this draft contains a new objective for Florida's Intrastate Highway System, further refinement will be needed to begin to reflect what outcomes, or results, are expected as we implement that system.*

However, throughout our interviews with key Florida leaders, the subject of monitoring the outcome of the actions taken by the agency was treated with considerable caution. Concern was expressed that if a given statistic (or indicator) is not known to be caused as the result of an agency action, it should not be labeled as an outcome of the acts of that agency. Rather, that piece of data may serve a critical function in helping the analyst to understand the problem, and begin the larger task of determining how the agency's actions have, or have not been related to that pattern. Within Florida's program of monitoring and tracking are a series of indicators that, in the view of the FDOT staff, should not be viewed as measures of the performance of the system, because they reflect the influence of many factors, not just the actions of the agency toward the system.

4.0 The Performance-Based Budgeting Process: Budget Program Measures

The concept of monitoring and evaluation of the existing system, carefully integrated into the long-range and short-range components, is not, by legislative mandate, being integrated into the year by year capital budgeting process for the FDOT. For the budgeting process, the DOT is reporting back on a series of Budget Program Measures, which were included as the last column included in Tables 3.1 through 3.5.

As noted in the paragraphs above, the Program Budget Measures vary widely in the kinds of information they track. In some cases, they are tracking the consistency of the annual budget with earlier policy commitments, such as the commitment to spend half of the statewide capacity improvement funds on the Florida Intrastate Highway System. At the same time, the yearly report back to the budgetary process is reporting on indicators which do not track the direct results of agency actions, such as the total tons of cargo shipped by air. The Department staff reported that they had significant concerns about the ability of the true results of the agency's actions to be trackable on a year by year basis. In fact, they were concerned that the temptation to choose easily trackable measures might lead to inappropriate policy directions, as discussed in Section 7.0 of this case study.

5.0 The Corridor and Systems Planning: Proposed Performance Measures

In Florida, the need for a standard by which to evaluate the quality of flow was established by the legislature, which created Florida Rule Chapter 14094, Statewide Minimum Level of Service Standards for State Highway System. The rule calls for the application of the Highway Capacity Manual methods, or, alternatively, other methods approved by the FDOT. Pursuant to this charge, FDOT has undertaken a series of studies to establish a consistent measure by which to evaluate service conditions for facilities, for corridors, and for systems as a whole.

A 1996 study on measuring transportation performance related the need for effective performance measures to the goals established in the FTP. That study noted that in order to support goals three and four, measures would be needed to assess both quantity and quality of transportation. In order to determine the *quantity* of transportation, a set of measures must be developed to measure the transportation system in terms of the number of people and goods being moved. In order to determine the *quality* of transportation, the set of measures must be developed which measure the efficiency of the transportation system in terms of travel time, speed, and/or level.

The study recommended the use of person throughput and average travel time for the corridor performance measures, and the use of person miles, average travel times, and average travel speeds for the system performance measures. The study also recommended the use of secondary measures, as described in Tables 5.1 and 5.2, below.

Shortly thereafter, a study on the most appropriate measures for the performance of the Florida Intrastate Highway System recommended the use of mean system speed and its inverse, mean travel time per mile.

Table 5.1 Performance Measures for Corridor Analysis (Florida Intrastate Highway System/Transit/HOV)

Measures		Units for Measure: Highway	Units for Measure: Transit
Effectiveness and Quality (Volume)	*Person Throughput*	Number of persons	Number of passengers
	Vehicle Miles	Vehicle Miles	Bus/train miles
	Average Vehicle Occupancy	Persons per Vehicle	Passengers per bus/train
Efficiency and Quality	*Average Travel Time*	Minutes	Minutes
	Average Travel Speed	Miles per hour	Miles per hour
(Time)	Density	Vehicles per lane mile	Passengers per seat
	Percent time Heavily Congested	Percent Hours	Percent Hours

Primary measures are in italics, while the others are used to verify and check the results.

Table 5.2 Performance Measures for System Analysis (Florida Intrastate Highway System)

Measures		Units for Measure: Highway	Units for Measure: Transit
Effectiveness and Quality (Volume)	*Person Miles*	Person miles	Passenger miles
	Average Vehicle Occupancy	Person per vehicle	Passengers per bus/train
		Vehicle miles	Bus/train miles
Efficiency and Quality (Time)	*Average travel time*	Minutes	Minutes
	Average travel speed	Miles per hour	Miles per hour

Primary measures are in italics, while the others are used to verify and check the results.

6.0 The Intermodal Management System: The Changing Role of Performance Measures

The FDOT has undertaken one of the nation's most ambitious applications of the concept of monitoring and feedback in its early execution of an Intermodal Management System (IMS). With the decision by Congress to make the management systems optional, many states abandoned IMS development efforts while continuing to pursue most of the other optional systems. Florida, however, continued developing an IMS process to understand system performance issues influencing both intermodal freight and passenger movements. In this section, the Florida IMS is reviewed in terms of its evolution from a program with systemwide emphasis to its revised orientation to the quality of the connections between key facilities and the rest of the transportation system. The attempt to use the system for prioritization purposes is reviewed, and the results of the management reevaluation of the program are presented.

6.1 The Original Concept: A Global, Systemwide Perspective

The original vision for the IMS named three main categories of factors: *utilization, safety* and *accessibility*; the category of accessibility was subdivided into convenience, modal inventory, transfer characteristics, and modal choice. Table 6.1 presents this original vision.

At this early point in the development of the concept, the study was planned to examine the characteristics of flow within transfer facilities (ports, airports, freight distribution facilities) as well as the quality of access to and from these facilities. Facilities would be observed in terms of their utilization, and in terms of their mode to mode transfer efficiency. Flows of persons and goods were to be modeled and analyzed on a statewide, interregional basis.

With support from a federal grant to develop a model IMS, FDOT produced a 1993 document (*Florida's Intermodal Planning Process*) that defined an ambitious program to model both statewide person and goods movement. Faced with the sheer scale of the proposed analysis effort and the then-perceived problems with meeting Federal deadlines for implementation, FDOT undertook a parallel, temporary track called the *Pre-IMS* program.

Table 6.1 Original Vision of Performance Measures for the Florida Intermodal Management System (1993)

Causative Factor		Measures
Utilization		Demand volumes/capacity usage
Safety		Incidents per year
Accessibility	Convenience	Travel/dwell times to or at the facility
	Modal Inventory	Number, type, service hours
	Transfer/Coordination and Transfer efficiency	Mode to mode efficiency
	Modal Choice	Mode split Commodity or passenger volumes Origin and destination

Table 6.2 Examples of the Qualitative Measures in Florida's Pre-IMS Strategy

Category of Facility	Performance Measure
Airports	Is the access road operating at worse than level of service AC≅? Are shared ride services provided?
Ports	Is the access road operating at worse than level of service AC≅? Do trucks encounter difficult turns on the main access roads? Is rail access available? Is the drayage time between rail and port more than X minutes?
Cruise ship terminals	How often is the parking lot full? Is there shared ride service from the nearest major airport?

However, the "Pre-IMS" program had a significantly different orientation that in turn influenced the early IMS strategies of many other states. In this new, supposedly temporary orientation, the IMS would document the quality of connections between the intermodal facility and the major elements of the transportation system. With the new orientation, the statewide modeling approach was replaced with a facility by facility review of the deficiencies of access to and from that facility. Table 6.2 presents examples of qualitative measures in Florida's Pre-IMS Strategy.

By 1993, Florida had decided to undertake a major program of documenting the quality of the system, based on direct personal observation of the needs and deficiencies of the major points of transfer and interconnections in the system. Importantly, the agency dropped all consideration of the capacity and utilization of the facility, and focused instead on the quality of access conditions. Figure 6.1, shows the original conceptualization of the data to be organized.

In the original concept, each facility would be visited, and direct observations would be made about the quality of access provided by each of the connecting modes, listed in the left most column of the table. Thus, the *rows* of the table describe the characteristics of each connecting mode, while the four *columns* describe the measures by which the connection is observed. Within each category of measurement, several measures were specified:

- *Physical characteristics*: Linkage available, Capacity of the mode;
- Financial characteristics: Out of pocket costs;
- *Service characteristics*: Headways or wait time, Average transfer time between modes; and
- *Usage characteristics*: Number of transfer bays or parking spaces, Existing Peak hour usage, Average Vehicle Occupancy.

With the proposed application of the measures (columns) to the quality of the modal connections (rows) shown in Figure 6.1, the original vision of the data collection effort also called for a qualitative summary of major deficiencies observed for each mode of access. A qualitative assessment of future requirements was then sought. Further space was provided on the scoring sheet for subjective observations about security, information, pedestrian access, and aesthetics.

The original vision of the data collection effort was very much associated with deficiencies in the system that needed some kind of attention whether via capital investment or a maintenance strategy. However, the program then began to evolve into something different, and began to be conceptualized as part of an attempt to make facility investment prioritization based on a rational quantitative basis. The initial concept behind the management systems had been to organize basic information about facilities and systems, not to replace the existing systems of project prioritization.

In 1995, a new data collection form was developed and tested, and took the program into the area of codification of data for project prioritization. As shown in Figure 6.2, a new format was developed in which the direct, empirical observations about facility or service condition were replaced by a point ranking scale for each performance measure. In this newly quantified approach, a transfer facility would be ranked by point score for such a measure as number of modes. A facility served by four modes would get four points, while a facility served by three modes would get three points, etc. In this scale, physical attributes could be ranked in terms of the performance. Vertical clearance of 16.5 feet would be awarded five points, while vertical clearance 13.5 feet would be awarded only one point. A railroad width of 22 feet would be awarded five points, while a railroad width of less than 18 feet would be awarded one point. Table 6.3 suggests that most of the data organized in this manner described asset characteristics, rather than measures of performance.

In this revised concept the data collection was taken to each of the districts, who, when applying the appropriate form to each of their intermodal facilities, could then be able to rate the overall rank order of each of the intermodal facilities in their district. Thus, rather than seeing the exercise as a chance to reveal conditions to the managers of the system, the new purpose was to support the development of a capital program, and establish the comparative need between projects within the same category, as expressed in the right-hand column of Figure 6.2, labeled "Rank Order – Like Facilities."

Figure 6.1 Original Conceptualization

TYPE: RAPID TRANSIT — INTER-URBAN INTERMODAL FACILITY

NAME — TOTAL CAPITAL COST:

COUNTY — O & M COSTS:

ADDRESS: — TOTAL REVENUE:

CONTACT: — REMAINING SERVICE LIFE (years):

	Physical Characteristics		Financial Characteristics	Service Characteristics		Usage Characteristics		
Connecting Modes	Linkage Available (yes or no)	Capacity of Mode (persons/veh)	Out of Pocket Cost ($/trip)	Fixed Route Headways or Wait Time (in routes)	Avg. Transfer Time Between Modes (minutes)	No. of Transfer Days/Parking Spaces (number)	Existing Peak Usage (number)	Average Vehicle Occupancy (persons/veh)
BICYCLE		1	N/A	N/A				1
PEDESTRIAN		1	N/A	N/A				1
PRIVATE AUTO		4		N/A				
TAXI/LIMO								
LOCAL BUS								
EXPRESS BUS								
FREE SHUTTLE			N/A					
RENTAL CAR		4						
RAPID TRANSIT								
COMUTER TRAIN								
PEOPLE MOVER								
HIGH SPD RAIL	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

CURRENT LINKAGE DEFICIENCIES FOR AVAILABLE MODES:

MODE: ______ DEFICIENCIES: ______

MODE: ______ DEFICIENCIES: ______

MODE: ______ DEFICIENCIES: ______

MODE: ______ DEFICIENCIES: ______

POSSIBLE FUTURE MODE REQUIREMENT OR NEED:

Figure 6.2 The Final Measures as Applied in 1996 and 1997

Questions to be answered/ Determinations to be made	Performance Measure	Units	Point ranking scale					Std.	Observed Measure	Field Rating	Point Rating Standard	Variance in Standard	Rank Order
Transportation modes served by facility (circle all that apply) Auto-Passenger AP; ??? AT; Rail Passenger RP; Air AR; Bus BS ???-passenger SP; Pedestrians PD; Bicycle BC; Other OT	NOT APPLICABLE												
Number of modes serving the facility (identified in No. 1 above)	Modes	N/A	4	3	2	1	0						
Horizontal, Vertical, Turning Radii, Impediments?	HV-Height HV-Weight Design Truck RR – height RR-width P-height P-width	Feet Feet N/A Feet Feet Feet Feet											
Lifecycle condition, design life remaining, adequacy?	Road Railroad	Years Years											
Number of pedestrian crossings within two miles of primary access point? Number of pedestrians per minute per foot over 15 minute peak?	Ped/ft ratio	N/A N/A											
Is movement to/from facility and nearest NHS point of access or railroad trunk line convenient (Ave. peak-hour travel time)	Road Railroad	Minutes Minutes											
What is the transfer time between modes? Is it adequate? Underutilized?	Time	Minutes											
Is the intermodal facility fully ADA accessible? Yes? No?	Yes or No	N/A											
Are reported accidents/injuries/fatalities by mode on the access route perceived as significant (percentage of on-link accidents to county total)?	Overall Passenger Bicycle	Percent Percent Percent											

(Note prioritization in right column)

6.2 Management Reassessment of the Program

After a two-year test period of the new IMS process, management performed a rigorous analysis and self examination and uncovered issues of interest to all states interested in the systematic documentation of the quality of the intermodal system. The manager of the program summed up the results of this careful process of evaluation by writing. "The future of Florida's Intermodal Management System in its current form is questionable. However, the acknowledgment that the intermodal planning process would and should evolve overtime remains a given."

Table 6.3 The Nature of Measures in 1996 IMS Scoring Process

Nature of Measure	Performance Measures in 1996 IMS
Measures of performance	Minutes of to nearest point of system access Transfer time between modes
Essentially asset characteristics and not measures of performance	Number of modes All access clearances (7) Remaining design life Pedestrian conditions
Difficult to categorize	ADA compliance Safety record Ratio of reported accidents to regional norm

In our interview with the managers of the process, it was reported that the concept of visiting the key points of transfer, and making direct empirical observation about the quality of access was considered a major step in giving attention to elements of the transportation system previously under represented in the planning process. However, the attempt to use the information gathering process to establish the comparative ranking among a very small group of highly dissimilar projects was considered to be a statistically difficult problem.

The fact that none of the districts utilized the Facility Rank Order field in the evaluation forms (this would have been the bottom line of each facility evaluation) reflects the reality that there were too few state significant facilities with each district to make useful comparison among like facilities.

In the preparation of a "White Paper" to examine best future for the program, the actual users of the system at the district level reported back their dilemma: support was expressed for further examination of the quality of the intermodal system, but the direction towards prioritization had become a problem. Most of the public transportation managers also indicated that the evaluation results were not suitable for ranking individual facilities at the district level for funding improvements. Although none of the districts have used the results for that purpose, four of the seven district survey responses showed a preference for retaining an IMS process in some revised form in the future.

The "White Paper" also recommended placing a temporary moratorium on the development of the IMS, but noted some important areas for continuation of the process. As will be noted in other case studies in this series, the inventory of intermodal facilities was felt to be important, and recommended for continuation at a statewide clearinghouse. It also recommends that any evaluation of rail freight intermodal and bulk freight intermodal transfer facilities *be limited to the evaluation of publicly-funded links to the rest of the system.* Finally, the focus on facility conditions was challenged, with the suggestion that performance measures examining the economic impact of the facilities would be desirable.

The self-assessment process resulted in specific recommendations for retaining and removing specific performance measures. The safety data was considered both low in applicability and difficult to obtain. Similarly, the pedestrian V/C ratio was considered not to be worthy given the difficulty to obtain it. The concept of suitability for truck use was determined to be best measured through an examination of radius of curvature at the facility. (Earlier in the process, all data about the actual throughput of the facility, compared with the theoretical capacity of facility was rejected as inappropriate for a study of intermodal connections.) Table 6.4 presents Florida's final recommendations on IMS performance measures.

Table 6.4 Florida's Recommendation on Intermodal Performance Measures (1997)

Recommendation	Performance Measure
Performance measures that should be removed or modified	• Pedestrian v/c ratio • Safety at highway rail connection • Safety for passengers • Safety of bicycles • Truck design radius
Performance measures that should be retained for further analysis	• List of modes • Road height • Road width • Rail height • Rail width • Pedestrian height • Pedestrian width • Road condition • Rail condition • Pedestrian crossing • Distance to NHS road • Transfer time • Mode split of freight • ADA Access • Dwell time

7.0 Summary of Management and Staff Perspectives

In addition to undertaking a review and analysis of the use of measures in major elements of the Florida statewide planning process, two days of interviews were undertaken with senior members of the statewide planning team in Tallahassee in the summer of 1997. This section of the Florida Case Study summarizes some of the key issues raised in those wide-ranging interviews.

■ 7.1 On the Role of Measurement

The Florida officials discussed the wide variety of mandates they have to make their governmental agency more accountable. In this context, they noted an interesting and important dilemma: in order to make their work more relevant to the larger policy issues addressed in state government they are aware of the benefits from linking their evaluations to larger societal goals, i.e., they understand the need to measure in terms of the *outcomes* of their acts. Yet, at the same time, the measures defined for them from the outside tend to concern either *outputs*, or more often, documentation of the efficiency of management. Considerable attention was placed in the interviews on the real problems associated with the integration of measures of outcomes into the planning process.

The Florida managers emphasized that the *process of monitoring the system for relevant data was the key issue*, while casting considerable skepticism on the concept that these pieces of information were, in and of themselves, measures of system or agency performance.

■ 7.2 Performance Measures versus "Indicators of Conditions"

In the view of some of the planners, the concept of early establishment of easily definable measures of performance is inherently flawed. In the interviews, the argument was raised that there are three serious flaws with the concept of evaluating performance of agency actions.

First, decisions are made in a political process not a needs-based process. In effect, the list of projects that emerges from the legitimately established democratic process is the best list of projects. Therefore, an information system should be designed to support that legitimate process, and not attempt to supplant it. A set of projects that leads to the continuation of funding, or even the increase in program funding may be a better set of projects than the set which results from the analysis of deficiency. In this model, long-range planning is a forum for dealing with irreconcilable conflicts said one planner. For example, to some citizens urban sprawl is an efficient way to gain locations for inexpensive housing, while for others, that same urban sprawl is a bad thing.

Second, and more germane to this case study, several of our interviewees argued that while performance measures can be used to describe a condition, they cannot be used to predict the results of an action or strategy. Several of the key staff members argued that there is, in essence, no such thing as a performance measure, in the normative or evaluative sense. Rather, transportation planners tend to rely on “indicators of conditions” that are extremely valuable to the managers responsible for programs. However, those indicators do not and should not in and of themselves, establish a full evaluation of system, program, or agency performance. The evaluation of performance should be done through the rational process, which incorporates input from many sources, including the substantial information contained in the indicators. By way of example, the argument was made that existing tools can measure throughput and utilization (indicators), but they cannot measure mobility (a performance measure). In their view, it is highly dangerous to imply that a ratio of one fact to another fact should determine whether a public policy is a success or a failure. As one staff member noted, measures should not be deterministic, but rather probabilistic.

Finally, the leaders of the Florida planning process expressed a strong concern that a narrow view of performance measurement might harm the quality of the management process. They expressed a concern that the linking of budget decisions to a yearly review of performance (here called budget program measures) might end up with a decision to go with easy measures, and bias the project selection process towards those investments which score well on the oversimplified measures.

> *Measurement is not an end in itself, measurement comes after you have decided what to measure. The problem is deciding what is the desired outcome. Do not choose your goals because they are measurable, choose them because they are right.*

7.3 The Measure as a Warning Flag

Most of those interview subscribed to an alternative view, in which the indicator of performance is used as a warning flag that triggers a process of examination and inquiry, and from that process a judgement can be made as to the desirability or undesirability of an action. One planner argued,

> *All useful aspects of performance measurement are unintended. Meeting the objective doesn’t mean anything. The measure should be used to encourage us to look in further detail at the problem.*

The Florida managers raised the issue of safety as an example of their concern. Goal One of the FTP calls for Safe transportation for residents, visitors and commerce. Florida is extremely concerned that their rate of accidents per million miles is significantly higher than the national average. For them, a statistics such as the ratio between Florida’s accident rate and the national rate serves as an *indicator* that there is a policy issue to be examined but it does not serve as description of the performance of the roadway system, or the performance of the Department of Transportation. Rather, this indicator of the phenomenon of automobile accidents serves as a red flag to the decision-makers, who can then trigger the appropriate analysis to understand the situation better.

FDOT has taken this red flag very seriously indeed, and has launched an in depth effort to understand to what extent, if any, the policies of the agency are causally related to the issue of accidents. Florida is committed to making an annual performance report, presenting a status report of developments relative to 15 short-range objectives. With this format, FDOT reports back to the public on the status of the highway fatality rate, in this case a decline. The process does not however, force the inductive leap that the agency's actions had caused the decline in fatality rate. Instead, FDOT identified a rather long list of those responsible for the change in the rate of accidents. This underscores the Florida team's strongly held belief that this indicator is *not* a measure of performance of the agency, but rather an indicator of a very important subject area that may or may not be influenced by the actions of the agency.

■ 7.4 The Implications of the Commitment to Monitor the System

The ability to track the characteristics of the system over the long-term remains a key element of the agency's commitment to improve its actual performance. Returning to the accident rate example, analysis undertaken by FDOT staff shows that of that high accident rate, some four percent of the crashes on the State Highway system have road-related conditions noted as a factor contributing to the crash. Based on this concern, the agency has set as a Short-Range Objective to lower the number of such to one percent of the total number of crashes. In doing this, the agency is moving more towards an outcome that is legitimately attributable to their actions.

It is important to note that FDOT does not use the performance information as a basis for minimizing agency responsibility. The Florida team's research has found that many of the non road-related factors are urban in nature and associated with vehicle/pedestrian conflicts that occur late at night and have alcohol consumption as a contributing factor. Researchers were able to discern a pattern in which mid-block crossings, (as opposed to cross walks) were associated with abnormally high rates of accidents. This in turn allowed the researchers to examine the role of urban form, and the relationship between strip development and the location of housing. Armed with this information, the team is in a position to explore alternative street layout and activity center designs with local land use planners, and deal more directly with the causal factors in this safety problem.

Given the evident empirical relationship suggesting that the high accident rate is not associated with the policies of the DOT, we asked the Florida managers if they felt this was an example of case of misuse of the idea of tracking the trends and conditions of the system. Their uniform response was that the case was just the opposite: *the commitment of the agency to track those conditions defined in the Florida Transportation Plan was the direct cause of the research to find out just why the problem existed and to explore alternative strategies to deal* *with the problem.* The mistake, they insisted, lies in the tendency to take the concept of a performance measure and use it as a quick oversimplification of a real issue that needs real attention. The existence of a program to provide monitoring and feedback as major commitment of the management process caused the highly profitable exploration into the causes of the safety problem. One participant noted:

> *You cannot depend on a simple ratio the measure is useful to set the process in motion. Just why did we think that the public is centered on measures? It is something you do. Measures are just a tool. The important thing is doing the monitoring, not the establishment of measures.*

■ 7.5 The Mandate for Use of Output Measures

Various external forces, (both legislative and executive branch) tended to push the Florida program away from outcomes and towards outputs. One planner explained,

> *There is a link between our long-range work and the short range capital budgeting. We started with the quality of life issues, we offered descriptions of what we were responsible for, but [elected officials] wanted to talk about detailed stuff, like how many acres are you mowing? We are watching them move to output again; we kept getting outputs as the measures they wanted. They are backing off of outcomes, certainly at the local level.*

Within the category of outputs, there is a considerable move to make them as relevant to actual experience and agency goals as possible. For example, initially in the budgeting process, the number of contracts let was the reported measure. This was changed to the number of potholes fixed, or the number of tons of asphalt used to fill the potholes to more accurately reflect the desired outcome of the policy (i.e., to have the potholes fixed) than the original measures.

8.0 Experience and Lessons

Because Florida was one of the first states to use performance-based planning concepts in program operation, observations from this case study provide useful insights on the evolution of such concepts. Some specific observations include:

- FDOT has found that a strategic linkage between all performance measurement components is helpful in understanding relationships between actions and results. FDOT's system is aligned from agencywide long-term goals through short-range objectives and measures for annual budgeting. The system includes a broad range of outputs, outcomes, and agency efficiency measures to gain a more robust picture of both conditions and performance.

- Performance measurement and monitoring are institutionalized throughout FDOT; these processes receive strong support and resource commitments from agency management and decision-makers outside the agency. This explicit support was mentioned as a contributing factor in staff's willingness to devote the time needed to develop and maintain the processes.

- The Florida managers emphasized that the process of monitoring the system for relevant data, rather than the selection of a specific performance measure, was the key issue. This periodic and systematic monitoring underlies all components of FDOT's planning process, and is used as a tool in understanding causal linkages with agency actions.

- Study participants suggested that successful performance-based planning is an inherently evolutionary process, with extensive fine-tuning required as the system is implemented. FDOT has used its monitoring and feedback process to suggest changes in goals, objectives, measures and indicators.

- FDOT management and staff have experimented with both output and outcome measures. Outside constituencies have suggested that FDOT focus on one or the other type of measure at different times. However, it was suggested that both measures are useful for specific applications, and that caution should be exercised in selecting measures that may be subject to considerable influence by other parties.

- Case study participants carefully distinguished between "indicators of conditions" and "performance measures." FDOT has used indicators as a triggering device to point out potential areas of concern that require further study.

- The evolution of FDOT's performance-based planning process into a prioritization process for the IMS was unsuccessful. Based on this experience, it was strongly suggested that performance measurement be used to inform current decision-making pro??cesses rather than replace them.

Case Study: Oregon IMS

1.0 Introduction

Throughout the country, states and regions have been looking at candidate policies and measures to use in the implementation of a performance-based planning process, with the intent of choosing a reasonable, accomplishable program. The Oregon Department of Transportation's (ODOT) Intermodal Management System (IMS) was developed through a logical and systematic review process that selected and narrowed the number of potential measures. Over the past five years, the program has evolved from an early global and inclusive set of possible measures to a refined and focused smaller set of working measures. The story of that evolution is the basis of this case study.

This case study traces the evolution and use of performance measures in the IMS at ODOT. This case study also reflects the needs and perspectives of ODOT, the Port of Portland and Portland Metro (the MPO for the state's largest urbanized area), all of which serve as partners in developing, managing, and using the IMS. The case study will focus on the evolution of measures over a four-year period, during which time the partners developed a commitment to monitor and understand the attributes and performance of connections into and out of the major intermodal terminal facilities in the state.

2.0 Measures of Performance, Measures of Condition and Asset Characteristics

The case study uncovered two different uses of the phrase "performance measures," both of which are understood and integrated into the management process of the Oregon IMS. The first concept is tied to the "performance measure" definition used in the formal performance-based planning model in which the measure of performance is tied to the policy action being examined. In this case, the performance measure documents the impact of the actions of the agency concerning that set of policies and actions.

A second use of the term refers to information that is generally of interest to the decision-maker when trying to understand the nature of a given facility's role, its deficiencies and/or its needs. In this use of the term, an almost unlimited amount of factual data can be reported in the process. In the words of a key Oregon manager, "It is not the way I use the term, but for some [individuals], 'performance measures' refer to everything that you want to track." Included in one family of observations are attributes that could not be changed by public policy (such as the distance of an airport from the city), attributes whose conditions are being monitored in some way (such as the existence of substandard curvature or grade), and measures describing actions that are directly under consideration by the process managers (such as level of service at key intersections).

Based on discussion with practitioners dealing with early lists of so-called performance measures, it is worthwhile to suggest segmenting the overall concept of a "performance measure" into perhaps several categories: *measures of performance*, *measures of condition*, and *asset characteristics*. The choice of three is, of course, an abstract construct. The reason for this segmentation is that within the broadly used category "performance measures," most of the proposed observations do not describe anything about performance. The following teaching example can help to illustrate the concepts of asset characteristics, condition measures, and performance measures. The teaching example concerns the observations about a boiler used to heat a bus garage:

1. The boiler providing heat to the bus garage is 30 years old. The boiler providing heat to the bus garage is located on a site that has hazardous waste nearby, and may have to be destroyed. The boiler which heats the bus garage is painted red, when it is company policy to paint all boilers bright yellow.

2. The boiler providing heat to the bus garage has three pipes that have substandard design. The heating coils are rated for 2,000 watts, when the demand often calls for a use of 2,500 watts. The insurance company visited the boiler and rated it a moderate to moderately unacceptable condition for a building such as a bus garage.

3. The boiler provided heat at a level of 58 degrees for 96 days of the 100-day winter. The company's policy called for heat at 58 degrees for at least 94 days, with no single day dropping under 55 degrees. As such, the boiler was rated as performing to the company's standards.

For the purposes of this case study, paragraph (1), which described the 30-year old red boiler located near hazardous waste, described the *characteristics of the asset*. The information in paragraph (2), which described the substandard pipes, the overworked wattage, and the insurance company's assessment, presented the results of *condition measures*. And, most importantly for this NCHRP research effort, the information contained in paragraph (3) described the *performance measures* applied to the operation of the boiler.

By comparison, on the other side of town, the company owns another bus garage. This garage has a brand new boiler, built to every standard. The manager is inept, and has no concept of maintenance, or even using the right kind of fuel. In this garage, there were 10 days with temperatures below 58 degrees, with six days below 50 degrees. Armed with this unhappy record of performance, the analyst would want to have relevant data from the condition measure and the asset characteristic before recommending that capital funds be expended for a new boiler.

Similarly, a transportation policy analyst beginning a quick review of the possibility of a deficiency or need would want to have data from all three of these categories in order to do his/her job. As was discussed in the Florida case study, an effective program of monitoring the conditions of the system would include a holistic collection of information, from which a reasonable public policy could be formulated. By way of example, if the analyst accepted only the data presented in paragraph #3 (the data about performance measures), then the analyst would have concluded that the boiler was performing well – no deficiency and no need is revealed. In fact, the information from the condition measure (the insurance company's rating, for example) and information about the asset characteristic (it is old and located near hazardous waste) could raise a red flag for the analyst, and trigger an in-depth analysis concerning the need to replace the boiler.

Returning to the ODOT study, the final (1997) list of IMS "performance measures" also provides an interesting view of this segmentation issue. The list included the following measures:

Concerning Airports:

- Miles to the nearest passenger rail station;
- Miles to the nearest bus station; and
- Linear feet of transit space for curbside availability per peak-hour passenger.

Concerning Rail Passenger Stations:

- Square footage of terminal space per peak-hour passengers; and
- Percentage of average annual facility fatality accident rate.

Concerning Rail Truck Facilities:

- Percentage of actual distance to straight line distance from facility to main roadway route; and
- Multiple roadways to facility from mainline.

Importantly, all of the information associated with each of these "measures" is of interest to the policy maker trying to gain a better understanding about the deficiencies and needs of the facilities being reviewed. Each of the eight measures above presents information that could profitably be labeled as "asset characteristics" or possibly "conditions" of the facility in question. The directness of the connection between a rail/truck terminal and the main roadway system could be valuable information in understanding why a given terminal is or is not used by the operators. At the same time, none of the eight measures claim to help us to document how well the facility is performing. In short, the refined list of performance measures in the Oregon IMS uses the phrase "performance measure" not to describe facts that measure performance, but rather to describe attributes or asset conditions.

In discussions with the state manager of the process, it was made clear that the phrase "performance measures" is a term that refers to all of the things you have chosen to track. Most of those measures will be an attribute of a facility, rather than a measure of performance in the strict sense. Thus, as in the Florida case study, the managers are emphasizing the importance of a program of monitoring of conditions – whether those conditions are directly linked to the actions of the agency or not.

3.0 Measures Examined in the Scoping Process (1993-1994)

During development and early implementation of the IMS work scope (termed "Phase One" by ODOT), ODOT considered a robust set of measures and indicators for both passengers and freight, as shown in Tables 3.1 and 3.2. In 1993, many states were attempting to establish just what they meant by the term "Intermodal Management System." Thus, Oregon, like Florida and many other states, set out to scope a system of looking at the efficiency of a statewide system. For example, on the freight side ODOT indicated that they would calculate "cost per trip and average travel time per trip" for all commodity categories on a statewide and systemwide basis. For each of the ports, they would "assess system structure, new facilities, and facilities in poor condition;" they would "measure port terminal utilization" by examining dwell time reports and facility designs. For the privately-owned railroads, they would document the "capacity restrictions, and average transfer times between modes." In order to get this information about the efficiency of privately-owned facilities, they sought to "review carrier/terminal operator reports."

Concerning passenger transportation, a systemwide scope was painted in the Phase One effort. For airports, the performance measures would "measure surface time travel between airports and all points in the state." To understand the functioning of that total system, the measures would calculate the "percent of aircraft and surface transportation departures outside of n minutes of schedule." In order to get this global overview of private operations throughout the state, the private carrier's operating logs would be examined and compared with its published timetables.

Another performance measure would "evaluate mechanisms for public/private negotiated agreements including service sharing between surface carrier types." In this case, the performance measure was being applied to describe an exercise in policy exploration: exactly what such a measure would be like was left unclear.

A prime concern of this research effort is the importance of establishing the policy purpose to be tracked or monitored before the selection of the measures. In general, the measures included in the two tables reflect a vision that was concerned with the total system experienced by the user – whether the user's experience occurred on facilities owned by the public or even influenced by public policy. The observations would cover both the public and the private realm (whether the operations were internal to the facility or dealt with the interaction between facilities). Thus, if an air carrier's service from Tokyo was poorly connected to the timing of its services to Seattle, this would be reported in the IMS.

Table 3.1 Measures Considered in the Oregon IMS Scoping Process (1993)

Goals	Type of Performance Measures	Type of Data Required	Type of Measure
Port System			
System status	Assess system structure, new facilities and facilities in poor condition	Facility status report	Condition
System utilization	Commodity flow and system utilization	Number of tons	Performance
Accessibility/ availability	Capacity restrictions, average transfer between modes	Port facility loading factors	Condition
System safety	System disruption, injury, death and property loss	Accident rate by type of facility	Safety
Travel times and costs	Cost per trip and average travel time per trip	Cost and travel time by commodity	Performance
Provide sufficient capacity at terminals	Measure port facility utilization	Facility designs and dwell time reports	Performance
Trucking Highway Road System			
System status	Identify major freight corridors	Network, mapping by designation	Characteristic
System utilization	Truck traffic	Number of trucks by axle classification, commodity information by origin and destination	Performance
System delays	Congestion on highway system level of performance standards	Peak and non-peak level of service	Performance
System safety	Accidents, injuries, etc.	Accident rate by type of vehicle	Safety
Accessibility/ availability	Capacity restrictions for trucks at intermodal facilities	Truck loading dwell and turn over times	Safety
Travel times and costs	Cost per trip and average travel time per trip	Cost and travel time by truck type and commodity	Performance
Provide sufficient capacity at terminals	Measure queuing of vehicles	Facility designs and dwell time reports	Performance

Table 3.1 Measures Considered in the Oregon IMS Scoping Process (1993) (continued)

Goals	Type of Performance Measures	Type of Data Required	Type of Measure
Railroad System			
System status	Track utilization and abandonments, track threatened with abandonment	Location and status of line facilities	Condition
System utilization	Commodity flow and system utilization	Number of tons, number of railcars, number of trucks	Performance
System delays	System disruption and blockages	Frequency and length of delays	Performance
Accessibility/ availability	Capacity restrictions, average transfer times between modes	Truck and rail loading times line capacity estimates	Performance
Travel times and costs	Cost per trip, average travel time per trip	Facility design and dwell time reports	Performance

Table 3.2 Measures of Performance of Passenger Transportation: Oregon IMS Scoping Process (1994)

Goals	Type of Performance Measure	Type of Data Required	Type of Measure
Accessibility/Availability			
Minimize distance to local service for as large a population as practical	Estimate the percent of population within *n* miles of services	Transit service plans, schedules, census data	Characteristic
Maximize access for the disabled and elderly	ADA compliance status	Paratransit and accessible service inventory	Multiple
Provide capacity at terminals sufficient to avoid queuing at intermodal transfer locations	Measure the queuing of vehicles and its relationship to overall delay	Facility designs, dwell time reports	Performance
Affordability/Cost Minimization			
Make the system affordable for the user	Cost of intermodal trip as a percent of the cost of auto use	Fare lists, auto operating costs	Performance
Minimize external and direct social costs as much as possible	Assess subsidies and environmental costs	Revenue recovery, quantified air pollution costs	Not a measure
Minimize capital expenses while meeting other service objectives	Use existing capacity versus new construction whenever cost/benefit ratio allows	Construction cost models, facility condition ratings	Not a measure
Connectivity Between Modes			
Connect local modes to intercity modes	Minimum layover times and distances between modes	Carrier time tables, service plans	Performance
Provide access between all modes	Measures of parking spaces per passenger, bike racks per passenger	Passenger counts, space counts	Condition
Connectivity Between Modes			
Ensure easy transfer between modes	Time and distance of transfer between mode to be *n* minutes and *n* feet	Facility design specifications	Condition

Table 3.2 Measures of Performance of Passenger Transportation: Oregon IMS Scoping Process (1994) (continued)

Goals	Type of Performance Measure	Type of Data Required	Type of Measure
Convenience/Benefit Maximization			
Make use of intermodal transportation as nearly as convenient as possible to the use of the car	Intermodal ticketing and luggage transfers	Existing ticketing choices	Condition
Promote information on service availability and intermodal options	Knowledge of existing and updated service information to all residents, travelers	Evaluate existing public information brochures, reports	Not a measure
Flexibility			
Have maximum modal choices within key corridors and links	Inventory of major o-d pairs having and planned to have mode options	Carrier timetables	Condition
Maximize schedule options	Provide 3 trips/day between Portland and other cities	Carrier timetables	Performance
Provide frequent airporter and other modal trips to airports	Set classification system of headway by traffic density	Carrier timetables	Unclear
Mobility			
Provide for a reasonable trip time	Average trip time by mode	Car mileage/speed/level of service information	Performance
Make public transportation travel time competitive with autos	Measure competitiveness by total travel times	Car mileage/speed/level of service information	Performance
Reliability			
Improve on time performance at terminals	Percent of departures outside of 15 minutes of schedule	Carrier supplied timetables	Performance
Reduce delays en route	Examine roadway and modal level of service	ODOT reports, local traffic studies	Performance

Table 3.2 Measures of Performance of Passenger Transportation: Oregon IMS Scoping Process (1994) (continued)

Goals	Type of Performance Measure	Type of Data Required	Type of Measure
Safety			
Improve safety while in motion	Accidents per passenger mile	Accident frequency and severity data	Safety
Improve safety of facilities	Crimes per 1,000 passengers; accidents per 1,000 vehicles at park-and-ride lots	Geographically-specific crime and accident data	Safety
Legal/Regulatory			
Reduce obstacles to service provision	Limitations to use of facilities by carriers	Car mileage/speed/level of service information	Not a measure
Encourage innovative service	Evaluate mechanism for public/private negotiated agreements including service sharing between carrier types	Car mileage/speed/level of service information	Not a measure
Economic/Environmental			
Create increased access to employment	Distance between service facilities and major activity centers	Employment and routing correlative data	Characteristic
Lead to an improvement in air quality	Vehicle miles traveled	Emission contours and emissions models	Performance

As described by the project manager, the key objectives of the Phase One scoping exercise were to:

- Describe policy implications of the IMS;
- Develop a preliminary inventory;
- Establish general measures of performance; and
- Identify data requirements.

The extensive set of performance measures shown in Tables 3.1 and 3.2 reflected ODOT's desire to assess different performance dimensions on an intermodal system that included:

- All intercity scheduled – service bus stations;
- All Amtrak depots;

- All airports with scheduled commercial service;
- All major lumber truck/train reload yards;
- All grain elevators at a port facility or on a rail line and exceeding 500,000 bushels of capacity;
- All truck/rail centers involving trailers on flat car (TOFC) and containers on flat car (COFC);
- Intermodal terminals at all marine ports shipping freight; and
- All oil pipeline terminals.

Confronted by the sheer scale of the options offered in the scoping study, the managers began an effort to narrow the scope of the process. What emerged, like in Florida, was a decision to abandon the concept of the IMS as a global repository of data about the many elements of the transportation system, and to focus on one concept – the quality of access into and out of major points of transfer.

4.0 A Revised Vision of the IMS

In Phase Two of IMS development, the ODOT team conducted stakeholder interviews to identify intermodal problems and needs, developed a database structure and performance measures, collected the necessary data, and identified strategies and actions for improving intermodal transportation movements.

By 1994, the Department had established a new, refined and redirected vision for the IMS. In a decision directly paralleling that made in the Florida case study, the managers determined that the focus of the IMS had to be narrowed to the quality of connections between the individual intermodal facility and the rest of the transportation network. Based on interviews with over one thousand stakeholders in the process, it was decided to focus the actual performance measures to five general categories: capacity, accessibility, connectivity, time delay and safety. As show in Table 4.1, the five categories of measures (as expressed in the original scoring sheet as columns), were examined for each of the modes connecting to subject facility (as expressed in rows). Within any given cell, any number of specific measures can be applied to the quality of connection between the facility's primary mode and each relevant connecting mode. (The reader can note the similarity of this scoring sheet structure with the initial scoring sheet concept for Florida [Figure 6.1 in the Florida Case Study]: the two concepts were developed independently and came to same concept.)

At the time of this decision, the managers of the IMS process had to chart a cautious course between data that were not directed toward supporting key decisions at the one extreme and data which in effect made prioritization decisions at the other extreme. The question of prioritization was a problem in the direction of the project. In 1994, the results of the Phase One process were summarized. That document noted the importance of leaving the act of project prioritization to the legitimately authorized existing process:

> *Scoping interviews identified the need to specify the relationship between the IMS and planning and programming. In particular it is important that the IMS is understood to provide the analytical basis from which intermodal needs are evaluated and strategies and actions identified. Whether the strategies and actions are incorporated into plans and improvement programs will be determined by other processes.*

The managers had to deal with the problem of providing information that would be useful in the prioritization process without establishing unrealistic assumptions about the role of the IMS. One state official stated: "We have to deal with the expectation that the management system will automatically give up priorities. [This represents] a big misunderstanding of the management system. The connector roads, the rail connectors – these are the things we should be examining."

**Table 4.1 Scoring Sheet Concept for Oregon IMS (1994)
Evaluation Matrix for a Given Facility (e.g., a Bus Station)**

Category of Measure Connecting Mode	Capacity	Accessibility	Connectivity	Time Delay	Safety
Whole facility					
Truck					
Rail					
Ship					
Car					
Transit					
Air					
Intercity bus					
Passenger rail					
Taxi					

At the same time, it was argued that for the management system to be relevant to the public decision-making process, it would be worthwhile to develop methodologies which could be used to compare the benefit from investment in one kind of facility over another kind of facility. Thus, at virtually the same time that the Florida IMS was being refined to provide a "rank order of facility need," the Oregon IMS examined a scoring system in which the number of "utiles" of benefit from the investment in additional port capacity, for example, could be compared with the number of "utiles" of benefit from an investment to improve the on-time performance of a passenger train.

With the decision to focus on the quality of access into and out of the key facilities, a new format for performance measurement was designed. To the original five categories, thresholds of acceptable performance were hypothesized for testing. According to the program managers, some were taken directly from established standards, and some were made up on the basis of some logical parallel situation. In Tables 4.2 through 4.11, the threshold is used as a concept that triggers a warning flag for further analysis by the policy maker. Thus, if a pavement has a load limitation imposed on it, the threshold value "Yes" sets off the trigger that more attention is appropriate. Other kinds of values, such as the number of 1,800 annual hours of truck delay, were built off logical scenarios, such as 100 trucks a day each experiencing three minutes of delay. The tables below show the structure of the so-called performance measures first applied to the whole facility, then applied to the connecting links to that facility.

Table 4.2 Facility Type – Connector and Mainline Roadways

Mode Connection	Performance Measure	Threshold	Type of Measure
Whole Facility	Average weekday P.M. peak hour v/c ratio	> .8	Performance
	Intersection average weekday P.M. peak hour entering v/c ratio	> .9	Performance
	Pavement with legal load limitations?	Yes	Condition
	Pavement with condition rating	> 4	Condition
	Bridge with posted load limitation?	Yes	Condition
	Annual truck hours of delay	> 1,800 hours	Performance
	Annual truck hours of delay from incidents	> 20 hours	Performance
	Presence of at-grade crossings?	Yes	Condition
	Presence of movable span bridges?	Yes	Condition
	Suboptimally timed signal progression	Yes	Condition
	Suboptimal geometrics	Yes	Condition
	Percent of statewide average annual fatality accident for roadway class	> 150%	Safety
	Percent of statewide average annual injury intersection accident rate	> 150%	Safety

Table 4.3 Facility Type – Air Passenger Terminals

Mode Connection	Performance Measure	Threshold	Type of Measure
Whole Facility	Percent of statewide average annual facility accident rate	> 150%	Safety
	Percent of statewide average annual facility fatality accident rate	> 150%	Safety
	Percent of statewide average annual facility property damage accident rate	> 150%	Safety
	Percent of statewide annual facility theft rate	> 150%	Safety
Passenger Car	Curbside availability?	No	Condition
	Linear feet of passenger car space availability per peak-hour passenger	< 0.3'/passenger < 100' minimum	Condition
	Average daily peak percent v/c total for parking	> .9	Performance
	Average minutes to park	> 15 minutes	Performance
Taxi/Shuttle	Curbside availability?	No	Condition
	Linear feet of taxi space for curbside availability per peak-hour passenger	< 0.03'/passenger < 40' minimum	Condition
	Standby?	No	Condition
	Integrated ticketing?	No	Condition
	Integrated baggage handling?	No	Condition
Intercity Bus	Curbside availability?	No	Condition
	Miles to nearest bus station	10 miles	Characteristic
	Integrated ticketing?	No	Condition
	Integrated baggage handling?	No	Condition
	Average mode connection exchange minutes between arrival at bus station and departure at air passenger terminals	> 120 minutes	Performance
Passenger Rail	Miles to nearest passenger rail station	> 10 miles	Characteristic
	Integrated ticketing?	No	Condition
	Integrated baggage handling?	No	Condition
	Average mode connection exchange minutes between arrival at rail passenger station and departure at air passenger terminal	> 120 minutes	Performance

Table 4.3 Facility Type – Air Passenger Terminals (continued)

Mode Connection	Performance Measure	Threshold	Type of Measure
Public Transit	Curbside availability?	No	Condition
	Linear feet of transit space for curbside availability per peak-hour passengers	< 0.03'/passenger < 50' minimum	Condition
	Average transit headway during A.M. time of peak hour plus one hour earlier	> 15 minutes	Performance
	Average transit headway during P.M. time of peak hour plus one hour earlier	> 15 minutes	Performance
	Integrated ticketing?	No	Condition
	Integrated baggage handling?	No	Condition

Table 4.4 Facility Type – Passenger Rail Stations

Mode Connection	Performance Measures	Threshold	Type of Measure
Whole Facility	Square footage of terminal space per peak-hour passenger	< 1.5 sq. feet per passenger	Condition
	Percent of statewide average annual facility injury accident rate	> 150%	Condition
	Percent of statewide annual facility fatality accident rate	> 150%	Safety
	Percent of statewide average annual facility property damage accident rate	> 150%	Safety
	Percent of statewide average annual facility theft rate	> 150%	Safety
Passenger Car	Curbside availability?	No	Condition
	Linear feet of passenger car space for curb-side availability per peak-hour passengers	< 0.3'/passenger < 100' minimum	Condition
	Average daily peak percent v/c total for parking	> 0.9	Performance
	Average minutes to park	>10 minutes	Performance

Table 4.4 Facility Type – Passenger Rail Stations (continued)

Mode Connection	Performance Measures	Threshold	Type of Measure
Public Transit	Curbside availability?	No	Condition
	Linear feet of transit space for curbside availability per peak-hour passengers	< 0.03'/passenger < 50' minimum	Condition
	Percent of trains met by transit within an hour before and after arrival	< 100%	Performance
	Integrated ticketing?	No	Condition
	Integrated baggage handling?	No	Condition
Taxi Shuttle	Curbside availability?	No	Condition
	Linear feet of taxi space for curbside availability per peak-hour passengers	< 0.3'/passenger < 40' minimum	Condition
	Standby?	No	Condition
	Integrated ticketing?	No	Condition
	Integrated baggage handling?	No	Condition
Intercity Bus	Curbside availability?	No	Condition
	Percent of trains met by buses within an hour before and after arrival	< 100%	Performance
	Miles to nearest bus station	> 5 miles	Characteristic
	Integrated ticketing?	No	Condition
	Integrated baggage handling?	No	Condition
	Average mode connection exchange minutes between arrival at bus station and departure at rail passenger station	> 60 minutes	Performance
Air	Miles to nearest air passenger terminal	> 10 miles	Characteristic
	Integrated ticketing?	No	Condition
	Integrated baggage handling?	No	Condition
	Average mode connection exchange minutes between arrival at air passenger terminal and departure at rail passenger station	> 60 minutes	Performance

Table 4.5 Facility Type – Bus Stations

Mode Connection	Performance Measure	Threshold	Type of Measure
Whole Facility	Percent of statewide average annual facility injury accident rate	> 150%	Safety
	Percent of statewide average annual fatality accident rate	> 150%	Safety
	Percent of statewide average annual facility property damage accident rate	> 150%	Safety
	Percent of statewide average annual facility theft rate	> 150%	Safety
Passenger Car	Curbside availability?	No	Condition
	Linear feet of passenger car space for curbside availability per peak-hour passenger	< 0.3'/passenger 60' minimum	Condition
Public Transit	Curbside availability?	No	Condition
	Linear feet of transit space for curbside availability per peak-hour passengers	< 0.03'/passenger 50' minimum	Condition
	Percent of buses met by transit within an hour before and after arrival of intercity bus	< 100%	Performance
Taxi/Shuttle	Curbside availability?	No	Condition
	Linear feet of taxi space for curbside availability per peak-hour passengers	< 0.03'/passenger < 60' minimum	Condition
	Standby?	No	Condition
	Integrated ticketing?	No	Condition
	Integrated baggage handling?	No	Condition
Passenger Rail	Percent of buses met by trains within an hour before and after arrival	< 100%	Performance
	Miles to the nearest rail passenger station	> 5 miles	Characteristic
	Integrated ticketing?	No	Condition
	Integrated baggage handling?	No	Condition
	Average mode connection exchange minutes between arrival at rail passenger station and departure at bus station	> 60 minutes	Performance
Air	Miles to nearest air passenger terminal	> 10 miles	Characteristic
	Integrated ticketing?	No	Condition
	Integrated baggage handling?	No	Condition
	Average mode connection exchange minutes between arrival at air passenger terminal and departure at bus station	> 60 minutes	Performance

Table 4.6 Facility Type – Marine Terminals

Mode Connection	Performance Measure	Threshold	Type of Measure
Whole Facility	Annual throughput value percent of capacity throughput value	< 50% or > 90%	Performance
	Percent of actual distance to straight line distance from facility to main roadway route	> 150%	Characteristic
	Multiple roadway routes to facility from mainline?	No	Characteristic
	Facility road access index for roadway connectivity to freight generation areas	> 100	Condition
	Trucks available?	No	Condition
	Rail available?	No	Condition
	Annual truck queue wait hour outside of gate	> 3,300	Performance
	Percent of statewide industry average annual facility accident rate	> 150%	Safety
	Percent of statewide industry average annual facility property damage accident rate	> 150%	Safety
Truck	Service level 8:00 to 5:00	No	Condition
	Available?	No	Condition
Rail	Service level 8:00 to 5:00	No	Condition
	Available?	No	Condition
Ship	Service level 8:00 to 5:00	No	Condition
Barge	Service level 8:00 to 5:00	No	Condition
	Available?	No	Condition

Table 4.7 Facility Type – Rail Truck Facilities

Mode Connection	Performance Measure	Threshold	Type of Measure
Whole Facility	Annual throughput value percent of capacity throughput value	< 50% or > 90%	Performance
	Percent of actual distance to straight line distance from facility to main roadway route	> 150%	Characteristic
	Multiple roadway routes to facility from mainline?	No	Characteristic
	Facility road access index for roadway connectivity to freight generation areas	> 100	Condition
	Percent of statewide industry average annual facility injury accident rate	> 150%	Safety
	Percent of statewide industry average facility fatality accident rate	> 150%	Safety
	Percent of statewide industry average facility property damage rate	> 150%	Safety
Ship	Service level 24 hours?	No	Condition
	Direct connection to port?	No	Condition

Table 4.8 Facility Type – Grain Rail Truck Reload Facilities

Mode Connection	Performance Measure	Threshold	Type of Measure
Whole Facility	Multi-commodity acceptance?	No	Condition
	Percent of actual distance to straight line distance from facility to main roadway route	> 150%	Characteristic
	Multiple roadway routes to facility from mainline?	No	Characteristic
	Facility road access index for roadway connectivity to freight generation areas	> 100	Condition
	Percent of statewide industry average annual facility injury accident rate	> 150%	Safety
	Percent of statewide average annual facility fatality accident rate	> 150%	Safety
	Percent of statewide industry average annual facility property damage accident rate	> 150%	Safety
Truck	Percent annual tons of potential throughput transferred (annual throughput/capacity throughput)	< 0.25	Performance
Rail	Percent annual tons of potential throughput transferred (annual throughput/capacity throughput)	< 0.25	Performance
	Unit train?	No	Condition
	Service level 24 hours?	No	Condition
	Direct connection to port?	No	Condition

Table 4.9 Facility Type – Other Petroleum Terminals

Mode Connection	Performance Measure	Threshold	Type of Measure
Whole Facility	Percent of annual barrels of potential throughput transferred (annual throughput/capacity throughput)	< 50% or > 90%	Performance
	Percent of actual distance to straight line distance from facility to main roadway route	> 150%	Characteristic
	Multiple roadway routes to facility from mainline?	No	Characteristic
	Facility road access index for roadway connectivity to freight generation area	> 100	Condition
	Percent of statewide industry average annual facility injury accident rate	> 150%	Safety
	Percent of statewide industry average annual facility fatality accident rate	> 150%	Safety
	Percent of statewide industry average annual facility property damage accident rate	> 150%	Safety
Truck	Percent annual barrels of potential throughput transferred (annual throughput/capacity throughput)	< 0.7	Performance
Rail	Percent annual barrels of potential throughput transferred (annual throughput/capacity throughput)	< 0.7	Performance

Table 4.10 Facility Type – Other Petroleum Terminals

Mode Connection	Performance Measure	Threshold	Type of Measure
Whole Facility	Percent annual units of potential throughput transferred (annual throughput/capacity throughput)	< 50% or > 90%	Performance
	Percent of actual distance to straight line distance from facility to main roadway route	> 150%	Characteristic
	Multiple roadway routes to facility from mainline?	No	Characteristic
	Facility road access index for roadway connectivity to freight generation areas	> 100	Condition
	Percent of statewide industry average annual facility injury accident rate	> 150%	Safety
	Percent of statewide industry average annual facility fatality accident rate	> 150%	Safety
	Percent of statewide industry average annual facility property damage accident rate	> 150%	Safety

Table 4.11 Facility Type – Air Cargo Facilities

Mode Connection	Performance Measure	Threshold	Type of Measure
Whole Facility	Percent annual units of potential throughput transferred (annual throughput/capacity throughput)	< 50% or > 90%	Performance
	Percent of actual distance to straight line distance from facility to main roadway route	> 150%	Characteristic
	Multiple roadway routes to facility from mainline?	No	Characteristic
	Facility road access index for roadway connectivity to freight generation areas	> 100	Condition
	Percent of statewide industry average annual facility injury accident rate		Safety

5.0 The Assessment of the IMS Managers

The managers of the Oregon IMS were optimistic about the structure of the management system to help bring about a program of performance-based planning. The MPO representative noted that:

> *In the regional plan, we came up with performance-based planning by default. Some of the need came out of urban growth management functional plan. We wanted to monitor the results.(but) for the IMS we specified a performance-based process from the start.*

The program was based in Oregon's history of the application of "benchmarks" of performance throughout state government. From the beginning, there has been ambiguity about what constitutes a "performance measure." The state's manager of the IMS noted that of the several hundred "performance benchmarks" used in the state government of Oregon, some of these are indicators of conditions, while others are specifically linked to normative, evaluative, concepts, often tied to a threshold value of acceptable performance. He noted that a new IMS contract has developed "some performance measures, and some thresholds to define need. Some of these were based on standards, others were best guesses." In some cases, he explained, they collected performance measures, and some cases they collected attributes. For example, "the data collected about marine facilities is almost entirely about attributes, and not measures of performance."

The results of the IMS process are now being entered into the key planning documents. The MPO manager noted that the work would contribute to a good freight component of the regional plan, where freight will be documented as a whole, where the concept of freight includes intermodal freight. He acknowledged that they had devised a complicated database for freight, which he felt was necessary to support the ambitious regional effort underway.

Several participants noted that early in the process intermodal freight had been separated out as an issue from freight in general. Several felt that this was an unfortunate by-product of the IMS process, as initially defined in the federal planning process. There is a feeling among the Oregon managers that examining a truck-only shipment in a different analysis system from a shipment that is by truck and rail, for example, was a mistake.

> *We have used the IMS for the update of highway plan, for the determination of the National Highway System connectors. The IMS is just the freight component to the regional plan, the state plan. We know inventory, we know condition.*

The managers are pleased that the IMS work has allowed the efficient coordination with the Statewide Plan and the Metropolitan plan. Most of the work underway now focuses on the roads to and from the major intermodal facilities, and this has provided for a direct input into state and local prioritization efforts. One manager stated: "I think it has helped in raising the visibility of the freight issue, but it should have been called the freight management system."

During interviews for this case study, it was repeatedly stated that the IMS served as a subset of the preparation of the long-range plan and as a support to shorter-range programming efforts. The members of the research team then asked, that, if the entire process was basically a subset of the Transportation Plan, and a subset of the Transportation Improvement program, then why should there be a separate "management system?" A representative from the Port of Portland argued that the process should continue as explicitly broken out from the rest of the planning process. She argued that "we tend to look at projects on an individual or facility base, and the freight issues need to be understood as more of a whole. Freight is part of a system and thus it needed a systems approach."

6.0 Experience and Lessons

The evolution of the Oregon IMS is strikingly similar to that found in Florida. The move away from a global management system to a focus on those elements of the transportation system under the control of the public agency (i.e., access links) was true in both cases. The trend toward using performance-based planning as a means of prioritizing projects, only to run into reluctance, was also found in both. Other specific observations that come from the Oregon Case Study include:

- Oregon had trouble with the initial scale of possible measures. Some were documenting the outcome of actual decisions made by the agencies, some were tied to thresholds of acceptable performance, and some were just interesting facts for consideration in the process; all were covered under the term "performance measures."

- Officials in Oregon ended up using the IMS a component mechanism in the preparation of a statewide plan, and the preparation of a regional TIP. But, after considerable exploration in the area, the IMS in and of itself turned out not be an effective process for ranking and prioritization. Rather, the IMS serves to provide meaningful input to the established processes of prioritization.

- The Oregon IMS generally turned out to have a dual focus on freight-only movement and intermodal movements. This dual focus was considered by some as a useful addition to the planning process because of previous neglect of this sector, but was lamented by others due to the loss of a total "systems" perspective. This illustrates the important roles that such a planning approach can play.

- Passenger, freight, and intermodal stakeholders provided valuable insights and opinions that aided in refining and focusing the IMS concept. The performance of over 1,000 stakeholders was therefore considered a difficult, yet worthwhile endeavor by case study participants.

Case Study: Washington State

1.0 Introduction

This case study explores the nature of various kinds of measures used in planning for freight systems in Washington State, at a statewide, regional, and metropolitan level. The study is based on the experience of statewide planners, district planners, and metropolitan planning organization (MPO) staff in Washington State. The Washington State experience is used in the case study to illustrate and explore key questions in the evolution of performance measures. It explores the logical use of measures that operate at the perspective of the individual facility, the management of the systemwide (often expressed as corridor-wide) and from the perspective of the user, or group of users. The case study reviews basic concepts of the programmatic content of the measure – whether the analyst seeks to monitor the efficiency of the transportation system or the effectiveness in accomplishing larger societal objectives. In addition, it explores the needs of the system planner for aggregate description of flows versus the policy analyst who may be interested in the mobility of separate users of market groups.

The case study examines the work of the Eastern Washington Intermodal Transportation Study (EWITS), one of the most ambitious studies of the mobility of disaggregate groups undertaken in recent times. Its in-depth study of the mobility needs of grain, barley, and apples represent a good example of a disaggregated user-based analysis of transportation. The case study looks at the difficulties of integrating this market-based data back into the established planning process. The commodity-based approach of EWITS is compared with a new process being developed in Puget Sound, which examines the flows on the basis of their economic characteristics. The case study concludes with a candid assessment of the project managers, who comment on the need for, the use of, and the misuse of performance measurement in transportation.

2.0 User-Based Analysis and Planning

The Washington State case study is largely concerned with the question of perspective. In other words, should the transportation system be viewed in terms of our role as owners of facilities, managers of systems, or from the perspective of the needs of the person or commodity undertaking the trip? The answer, of course, depends on the role of the individual doing the monitoring. For the employee of the Turnpike Authority, a principal role is to monitor the performance of the facility. For the statewide highway administrator, a principal role is to monitor the performance of the system. For the public policy analyst, measures describing the needs of the traveler or commodity are needed to understand the effectiveness of a given public action.

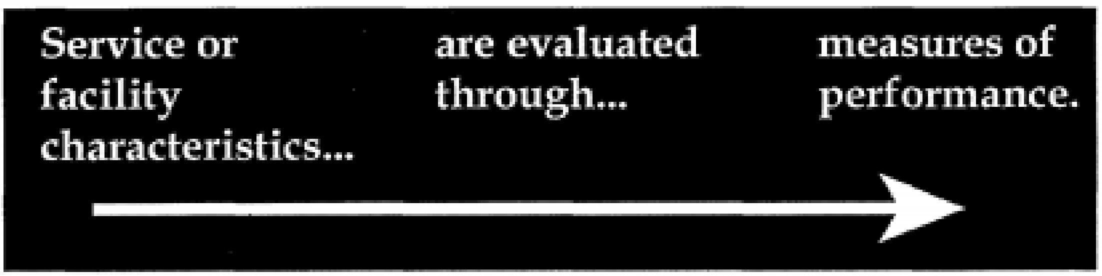
Table 2.1 has been created to array the three levels of *perspective* against two levels of programmatic *content*, labeled efficiency and effectiveness. The table illustrates the concept that the three perspectives apply equally well to measures of system efficiency as the result of a public policy action, and to the effectiveness of that action. In this view, when an action or strategy improves the characteristics of the transportation system itself, it can be said to improve the *efficiency* of the system. (Under some terminology, this can be called an *output* of the transportation agency.) When a strategy or action improves the performance of the system in relation to a wider societal goal, it can be said to improve the *effectiveness* of the system. (Under some terminology, this is labeled an *outcome* of the actions of the transportation agency.) However, the reader will note that there are wide variations in these terms. Washington State describes the inventory of physical things produced as an output, while outcome refers to some resulting characteristic, such as increase in speed or lowering of travel time.

Table 2.1 Perspective vs. Content

Perspective Content	Facility	System	User
Efficiency	The level of service on this bridge has improved.	The average speed over the whole corridor is better.	*My* travel times to work got better!
Effectiveness	The investment on the HOV lane on this bridge should help the overall carpool strategy.	These corridor characteristics should encourage people to carpool.	It now makes sense for *me* to form a carpool with my friends!

Figure 2.1 presents another graphic summary of two ways in which system performance can be tracked and evaluated. In the first view, implications of thousands of trip segments are examined in terms of their aggregate impact on a facility, or on a system. The manager tries to understand and manage the performance of the facility or the system. The phrase "vertical integration" can be applied to the pattern of evaluating the quality of the system as experienced by the modal or system manager. Without question, this "vertical" metaphor describes the way in which most transportation professionals in the public sector are organized, and most evaluative data is organized to support their needs.

Figure 2.1 Horizontal Integration Resulting from the Logistics Revolution



Airport	Highway	Tunnel	Transit	
Trip Segment	Trip Segment	Trip Segment	Trip Segment	Experience of User Group A
Trip Segment	Trip Segment	Trip Segment	Trip Segment	Experience of User Group B
Trip Segment	Trip Segment	Trip Segment	Trip Segment	Experience of User Group C
Trip Segment	Trip Segment	Trip Segment	Trip Segment	Experience of User Group D

In the second view, the manager of an overnight express company tracks the extent to which every parcel has completed its trip from door of origination to door of destination. The thousands of trip segments in the system are organized in terms of the user, or in terms of distinct market **groups of users**. The manager may have one series of strategies to deal with users who want their parcel by three in the afternoon, another strategy for those that need delivery by 11 a.m., and still another set of strategies for those needing delivery before 8:30 a.m. The phrase "horizontal integration" can be applied to the organization of data in this manner.

There are very strong advocates of a planning process that monitors the end products in terms of the needs of the person or commodity being transported. In a discussion aimed at public sector planners, one intermodal leader defined three steps in the intermodal planning cycle:

1. Understand the needs of the customer for the total trip (from door to door);

2. Choose the optimal routes and modes based on that understanding of the needs of the customer; and

3. Examine the quality of the points of transfer and interconnection needed along that path.

The development of a new, multimodal planning process that learns from the lessons of intermodal managers will shift the focus away from the modal characteristics of the trip, toward the needs of the person or thing for transportation. This case study explores two freight-planning applications in Washington State that directly considered user-based measures.

The Eastern Washington Intermodal Transportation Study (EWITS) is of interest from the perspective of data organization because it has taken the concept of a user-based (or in this case, commodity-based) perspective farther than any other known study. In Puget Sound, data that has been traditionally oriented around the characteristics of a zone of land is being organized in terms of the needs of the commodity.

In the transportation planning profession, the need for applying this kind of measure to the transportation system has historically been more acknowledged in theory than in fact. In most practice, the transportation manager often has excellent data describing the performance of a given segment of road, or tunnel or even the efficiency of the operation of an airport. Very few transportation studies have been oriented towards actually collecting the data to understand the total experience of the users through their total trips. Indeed, in order to gain this ability to track the total trip of every parcel, major transportation companies have spent literally billions of dollars each to establish this capacity for monitoring, evaluation, and feedback.

Nonetheless, there has been movement over the past several years towards the use of user-based observations in the monitoring of the performance of the transportation system. Whether this stems from philosophies such as Total Quality Management, or simply from the development of measures attempting to increase accountability to the political process, interest in this form of measure has increased.

3.0 EWITS as an Example of User-Based Approach

Created within the authorizations of ISTEA, EWITS has taken some of the most innovative and challenging approaches in recent transportation planning. In this highly innovative pilot research effort, the orientation of the study is to understand the specific logistics chain of each commodity of interest to the student of transportation in eastern Washington. And from this in-depth understanding of the logistics need of the separate commodities, it creates a database that the transportation planner can use to understand policy implications of alternative transportation policies.

While most transportation studies focus on the performance of the system, EWITS focuses on the use of the system by each of the commodities. EWITS examines the mobility of grain and apples. In doing so, it first documents the mobility needs of the grain – from the fields to the grain elevators, from the grain elevators to the barges, from the barges to the milling plants, etc.

In most transportation studies, the flows of thousands of user-groups, and thousands of commodity types are examined in the aggregate; the quality of the system is observed in terms of the aggregate result of all of these flows. The results are familiar; total volumes on links, speeds for those links based on those volumes. Travel times based on those speeds on those links. All of these calculations are about the cumulative aggregate of thousands upon thousands of smaller scale user groups.

A disaggregated approach to transportation planning would tend to look at the characteristics of many smaller units of user groups. And, as the field of transportation is more and more called on to be responsive to issues of larger societal interest, understanding of separate market group's behavior may become increasingly more necessary. For the transportation analyst understanding the causality of air pollution, understanding the nature, timing and characteristics of the first trip when the catalytic muffler is cold might be more important than understanding a trip later in the day, when no cold start was involved. For the transportation analyst understanding the need of welfare recipients to jobs, the characteristics and the market behavior of that group of people might be critical to understanding how the strategy should be structured. For the airport access analyst, the tendency of certain market groups to make pick-up/drop-off trips may be more important than other group's use of parking facilities.

EWITS creates what must be called highly disaggregated data. The study examined the timing of the apple crops, the timing of the grain harvests, and the timing of other commodity activities. The study examined the nature and timing of the trucking to temporary holding areas. Importantly, the EWITS data is also used in support of the analysis of facilities, based on an understanding of the characteristics (weight, seasonality, etc.) of the commodities using those facilities. The study was able, for example, to trace the loadings of the paper industry trucks on specific routes, and predict when unusual maintenance needs would occur.

In the interviews for this research, the statewide, district-wide, and research managers were asked about the usefulness of the data that was developed. One cited example relates to a proposal for reservoir drawdown on the Snake and Columbia Rivers. Because of their extensive database describing the logistics chains of commodities currently being barged on the two rivers, the managers were able to understand the possible implications of any shutdown of the river system to barge traffic, in order to minimize environmental danger to salmon. Armed with the origins, the destinations, the modal needs, and the unique timing requirements of the grain, EWITS managers could predict the implications of the seasonal closing of the river. One state manager summarized:

> *EWITS helped us understand the drawdown – a real intermodal trade off... EWITS data helped... Before EWITS we did not know when wheat was being shipped... Ken (Cassavant) found that wheat doesn't move much during the drawdown... Ken did a study of impacts of role of rail and highway. The closed river would redistribute the traffic. Flows from road to river were state-owned, while the road to railheads were county-owned. The actual ton-miles go down, but the pockets of destruction go up.*

The study has succeeded in improving the understanding of the needs of various forms of commodities on the state's multimodal system, including the timing needed for various shipments:

> *EWITS has defined seasonality for lots of projects. Grain needs to go into elevators quickly, then moves evenly over nine months... EWITS served to bring the industries up in profile... Talk about just in time! Hay and alfalfa is grown in the east and carried to the west... Hay is a just-in-time delivery... It is just about impossible to store the hay...*

The data have also been used in the process of evaluating investments on candidate roads, although that has not been its prime application. Interestingly, the managers reported that the county system was the first to use the database for evaluating roadway investment: The managers suggested that the best example of real freight mobility was the state's commitment to all-weather roads. The state has set an objective of creating a total system of all-weather roads. "EWITS info helped us locate the key roads. Having this information impacts on how we make decisions. We now know more about truck weights."

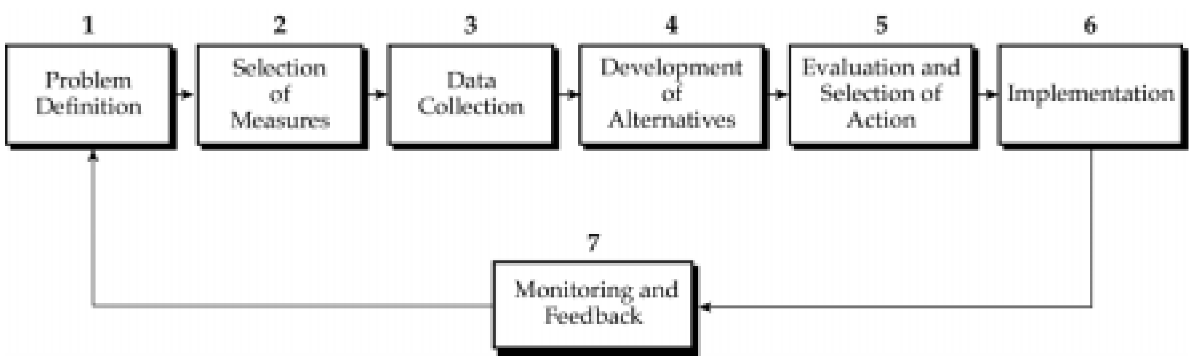
Now, the districts are preparing for the advent of "performance-based budgeting." They believe that the EWITS data will help them build tracking systems for "outcome, output, and efficiency." They also intend to build system indicators that relate to societal outcomes as part of this budget tracking process.

4.0 Service Objectives-Based Planning for Freight at WSDOT

There was a strong interest in the concept of planning with an emphasis on the role of monitoring, evaluation, and feedback. At the commencement of most interviews, a diagram (Figure 4.1) showing a simplified form of the planning process was shown. In Olympia (Washington State DOT headquarters), the reaction to the diagram was immediate:

> *...that's it! That is our basic model; it is the performance-based planning approach. In our system service levels lead to deficiency, which leads to analysis, then monitoring, and then feedback... [The diagram] is the state planning process. EWITS is outside of that flow... The policy-based planning process – not EWITS – defines problem and data gaps. We use EWITS [as a support tool]...*

Figure 4.1 A Simplified Model of the ISTEA Planning Process



Washington's statewide planning process, as described in the interviews, represents the major commitment to the development of a user-based program of tracking the performance of the system:

> *Mobility measures? We are getting into it in a big way. Continuous improvement for the customer ... Up to now, we have been tracking outputs and we want to move to outcomes. The plan was built on service objectives, which are outcome in nature. We have appointed a committee. We did a customer satisfaction survey.*

However, decision-makers in Washington State are wrestling with the same set of definitional problems as their counterparts in Florida. Although it is the national convention to place just about any observation under the broad category of "performance measures," both states are trying to use the word "indicator" to describe all but the most specific acts of measurement.

This is a systems indicator, and performance measures need to be tied to actions that we are taking. You can't have a performance measure unless we are taking action. They are tied to actions ... accident rate at the location of improvement is a performance measure, others are best called indicators... It is a performance measure if it tracks our objectives'; it is an indicator when it has no direction specified.

During the interviews, research team members suggested that EWITS could be used as a performance measurement tool to monitor the quality of the grain shipment from the fields to the place of export. However, for Washington's statewide managers the EWITS tracking of the world of grain was not an example of performance measurement:

Is that grain a DOT problem? Is the problem from a lack of an all-weather road, then it is a measure of performance ...(but).. if we do not intervene, then it is not a measurement of us.

In another interview we asked a different manager about EWITS data that would report the cost to ship an apple to the port:

If the cost to ship the apple goes down, this is an outcome for the apple industry. The impact of that truck on the roadway system – that is an outcome. It is not an outcome for me if I didn't do it.

In a separate interview at the Puget Sound MPO, a similar viewpoint was expressed: "Each supply chain will have its own performance measure – but this is not the public's problem."

A word of caution was expressed about jumping directly into measures of outcome: "It is hard to find direct causal relationships between policy and outcome." There are clearly some cases where the outcome can be quickly defined:

We have an objective to achieve the lowest life-cycle cost for pavement: the output is the volume of pavement; the outcome is the lowered life-cycle cost. Take rural level of service below D: we named that as part of our objectives, and that determines if it is an outcome.

The Washington State DOT managers are aware of the creative uses of highly detailed information about the needs of "customers" of the transportation system, as noted above. At the same time, they note that in order to help them with the task of monitoring the system, this data has to be reaggregated back up to the systems level.

We take a user-based market approach, but it should be based on a reaggregation of user needs... The traffic stream is made up of the separate markets: first we have to disaggregate it, second we have to aggregate it back up, and reaggregating it back is the real problem. What did we learn? Take the whole fruit industry, they are noise on the mainlines of the system, so what should we do with that industry? ... We have the disaggregate data – now the question is what to do with it. Now we know that cherries go from little airports to little airports.

This points out that while disaggregate data on individual market segments are very useful, aggregate flow data are still viewed as critical for analysts, managers and decision-makers. Once again, we see that the selection of measures and indicators needs to reflect the particular decision-making need.

5.0 Freight Transportation Planning at the Puget Sound Regional Council

In the previous section of this case study, we noted how the EWITS database was oriented around disaggregate commodity flows, rather than facilities, links or segments of the roadway system. From the analysis of EWITS process managers, it was noted that powerful data becomes available to the decision-maker by disaggregating overall flows into component parts, and understanding the needs of the separate market groups and commodities. In the terminology of this research, this represents a shift to organizing data in a user-based, or market group-based perspective, hopefully to be used to supplement other forms of observation based on a facility or systems perspective.

For some, data organized by industry group – such as the wheat growers or paper products manufactures – primarily yields information at the anecdotal level; the problem comes in reaggregating that data back to a systemwide perspective. At the Puget Sound Regional Council (PSRC), applied research is now underway to develop a process that analyzes the movement pattern of thousands of separate commodities, and reaggregates them back for use in systematic analysis.

5.1 The Historic Reliance on Aggregate Observations from Land Use Characteristics

For years transportation planners sought to apply some variation of the four-step travel demand forecasting model to the issue of freight. The goal was to forecast link flows over the network by mimicking the process which evolved for passenger vehicle forecasting. A key step in this process is the creation of a land use inventory in the base year, or a land use forecast in the future analysis year. Through a variety of processes, trip tables are created for passenger and/or freight trips that address broad travel categories such as home-based work, home-based other, non-home-based work and non-home-based other purpose. *The transportation analyst knows little or nothing about the actual content of the freight trips being forecast or analyzed.* Data is produced on an aggregate basis, such that the calibration of total flows compares with known ground counts.

Most important, the updating of these zonal averages requires a major land use survey, which is an extremely costly and time-consuming procedure. At the PSRC today, the freight planning team is experimenting with a procedure that derives transportation flow data, specifically truck trip generation data, from economic sources outside the transportation sector. For our purposes, the key observation to be made is that PSRC is developing an analysis process that is commodity-based, rather than land use-based. As one manager noted:

> *We started to try to replicate what we did for person trips. But freight changes more than person travel. Now we look at our economic sectors; we project where it needs to generate or attract. With a limited amount of some spot location of O-D, the observed empirical inventory becomes the freight network.*

5.2 A Shift to a Commodity-Based Perspective

There are major positive implications for the analyst concerned with measures of effectiveness from the development of this process. At Washington State DOT, policy analysts are now stating an interest in understanding the nature of the commodity being carried in some detail: "are the trucks carrying commodities central to the state's ability to generate wealth, or are the trucks carrying commodities for economic entities that redistribute a fixed amount of wealth?" Since the analysis of commodity flow is undertaken on a block by block basis, based on the characteristics of individual enterprises within that block, the nature of the commodities going in and out of the analysis zone and the nature of its logistics chain can be undertaken. The data are actually produced on a disaggregate basis and then brought up to a higher level of aggregation.

At the moment, the PSRC team is not attempting to assign these trips to actual links and networks, or to link origins and destinations in a systemwide application. Rather, the process is being used to help decision-makers understand the make up of freight flows, and understand the linkage between those flows and the economic activities of the community. At this stage of development, it could be argued that the data does not support the examination of the *efficiency* of the system. At the same time, the potential for this data to support the examination of the *effectiveness* of the system, and its interaction with the economic system, is immense.

5.3 The Basis for the Freight Analysis Program

The managers emphasize the linkage to economic issues when explaining the original purpose of the study of regional freight flows:

> *We wanted to understand nature of freight mobility (80 percent is private). We wanted to know where public decision points are. We have limited resources, and we wanted to know how freight mobility is tied to jobs.*

5.4 The Process of Monitoring the System and the Proposed Measures

Working with the Freight Roundtable, which is now in its fourth year, the PSRC has developed a monitoring program in which 26 critical segments of the roadway system are monitored, mainly measuring conditions experienced by trucks. These 26 segments represent many of the key locations between the port exits and the major warehouses. As for a label for this process, the project manager is conservative:

> *I'm afraid it is stretching it to say we have performance-based planning from our roundtable. But, we do believe that performance measures would insert that discipline. The process might be useful to strategically establish priorities.*

Working with the development of PSRC's Congestion Management System, the staff has come up with several lists of potential measures. Early work in that effort focused on the level of congestion generally experienced by freight and passenger vehicles alike. More recent lists of candidate measures emphasize the revealed issue of non-recurrent congestion. In the words of the project manager:

> *"All congestion is equal, but some congestion is more equal than others." This insight helps make the necessary point that performance measures for freight mobility are unsatisfactory if they simply measure "congestion" in a general way. [As indicated in Table 5.1], the freight performance measures and indicators place highest priority on capacity and on customer-based total-trip reliability. In addition to customer-based reliability, other competitive and operational measures for freight mobility include: access, time and congestion, cost, and safety. And more broadly, the freight mobility system also will be evaluated in terms of the overall regional economy, community development patterns and social impacts. All of these measures are used at least as a checklist to report trends, and in time can be further developed and more systematically applied.*

Table 5.1 Proposed Performance Measures and Indicators

Performance Measure	Indicator
1. Reliability:	
• Non-recurring delay (incident-related) impact on freight.	Accident rate/incident response on designated freight routes.
• Customer-based total-trip (systems.)	Ongoing consultations with shippers/carriers.
• See also No. 3, Time and Congestion (below).	
2. Access:	
• Major freight movements with modal alternatives.	Marine/rail truck.
• Highway. Bridges with vertical clearance restricts. Highway bridges with load limits. Intersections with inadequate turning radii for 53′ trailers. Locations with narrow lanes.	Prepare design manual.
• Railroad bridges on freight main lines with vertical clearance restrictions.	
3. Time and Congestion:	
• Port facilities. Ship unload times travel times to intermodal terminals.	Dispatchers, CMS trip times.
• Trucks. Recurring delays – impact on freight. Non-recurring (half of total delay). Roadway lane retention.	Vehicle/capacity ratio (V/C). Level of Service (LOS). No increase in travel times between selected points (from dispatcher and Congestion Management System). Improved incident prevention/response on designated roadways; and route redundancy. Ensure lane conversion (for efficient auto use) does not impinge o truck lane requirements.
• Trains. Rail speed restrictions. At-grade crossings. Trains disrupted. Disruption ratio. Political environment.	Improve the minimum and the average speeds. System operations (possible joint use Union Pacific and Burlington Northern tracks). Delay ratio: time of delay divided by total running time. Likely rescheduling needed. Percent of trains disrupted. Ability to attract railroad interests to Pacific Northwest segments of their larger systems.
• Airport delays.	Annual service volume (based on an accepted average annual delay). Daily delay (based on periodic weather conditions).

Table 5.1 Proposed Performance Measures and Indicators (continued)

Performance Measure	Indicator
4. Cost/Benefits:	
• Daily value of commercial time in travel.	E.g., reduce deadheading (a benefit of intrastate trucking deregulation).
• Impact. Revenue generated to the regional economy. Environmental costs/benefits	Direct/indirect/induced. Non-dollar costs/avoided costs.
• Port Operations. Volume. Vessel calls at the ports. Gate hours. Relative port costs to steamship lines. Dock time. Rail time.	Tonnage, acreage, efficiency. Foster staggered lunch breaks. Puget Sound versus California ports.
• Airport. Tons of Cargo. Parcel delivery. Efficiencies. Business activity generated. Surface access to airport.	Split between all cargo aircraft and commercial aircraft.
5. Safety:	
• Rail-grade crossings. Train collisions. Individuals.	Grade separation priorities (nationally, roughly 600 fatalities/year attributed to autos at rail crossings). Surveillance and spacing of trains, especially on mixed use mainline tracks (rail, commuter). Train speeds and corridor fencing in urban areas.
• Truck-lane-switching and locations with high rates of truck accidents. Driver fatigue.	Nationally, over 4,000 fatalities/year involving heavy trucks, with driver fatigue a factor in many of these – e.g., avoid unnecessary gate delays for long-haul drivers.
• Marine.	
• Aviation.	
• Non-motorized hazards for pedestrians.	Pedestrian accident records and patterns.

6.0 The Role of Freight Measures – The View of the Practitioners

6.1 The Nature of Freight Planning

A key question for the study of freight, and the application of freight, is the definition of the policy issues that need to be examined and developed through the process. In all of our interviews, the practitioners brought up the issue of "freight mobility." Importantly, all of those interviewed tended to downplay any sense of an overall crisis, or an overall failure, but rather to emphasize the key issues that the freight stakeholder community does raise. Is there a freight mobility crisis? At the MPO level, one planner noted that congestion does not dominate the concerns of the stakeholders:

> *We keep looking for the problem, but for the system as a whole we haven't defined the problem. No, Boeing has no problem with the total system. A particular need, like a grade separation will be noted. But we are constantly being told that "the problem is congestion, but we have not established this... Freight is so complex, but there is no problem!*

At the state level, the DOT has structured its planning process to incorporate freight concerns, but they have not isolated any crisis of freight mobility.

> *We have an objectives-based planning process. We have freight mobility as an objective and can fix problems that are raised. Freight mobility is separate, but has been hyped too much... We did focus groups, 600 interviews. People glaze over on freight mobility but understand is it important. People say it is easy to move goods in this state. They say it is not a problem... The attempt to define freight mobility as a public issue has problems. The public looks at congestion and impact on their own lives.*

To managers at both the state and regional level, basic network conditions form a given, to which the free market reacts with various strategies. A state manager noted:

> *Freight is problematic to us. The freight system is fixed. So they work around it ... everything is logistics about how to use it... A situation arises when hot spots mean they cannot make a round trip... The Seattle Tacoma corridor is such a [hot spot].*

The practitioners look at both the short-term and long-term logistical responses to the reality of recurring congestion. An MPO planner noted both the immediate logistical response (choice of alternative routes) and the longer-term response (shifting the location of key facilities).

> *We sat in a Boeing office – they are shifting to just in time delivery, with timed routes every half-hour. Hundreds of drivers report on alternative routes. They just moved*

their external warehouse to Seatac airport when they thought that was a problem. Over time private economy will adapt – over time!

6.2 The Need for User-Based and System-Based Measures

There is no agreed upon "best" measure for the quality of service on the system. One state manager gave a warning to those who would ignore system-based (or congestion-based) measures, in favor of sole reliance on user-based measures. *"Everyone wants to go to travel time. but it gets wasted in housing,"* noting that when road travel times get better, people can alter their housing location and move a greater distance from their employment. In such a situation, the altered running speed of the system does not appear on the user-based measure. Relying solely on user-based measures, the decision-maker would not be receiving critical information on the performance of the system.

You need congestion-based and user-based...[you need] a good diagnostic tool of where the system is not working... People hate the non-recurrent delay... Don't start with a standard of free flow, start with the basic conditions

Bringing some resolution to the issue of user-based versus systems-based measures, there was agreement among the practitioners that the logical model for the planning process was one in which both kinds of information are made available to the decision-maker.

In practice, the system tends to operate with a combination of qualitative user-based feedback, and quantitative measurement of the performance of the system. With the warning that the system is not working, the planner can try to apply the quantitative system to understand the problem better. Several mangers noted that the quantitative process usually occurs *after* the problem has been understood:

We get information out of the customer early – often before quantitative data arrives... The diagnosis of problem happens before the measurement is quantified. The problem is identified by anecdotes ... then we go out to analyze and systematize.

6.3 The Need for User-Based and Market Group-Based Measures

Not all practitioners we interviewed agreed on the "optimal" perspective for the measures. For some, the experience of the individual citizen was the building block on which to structure a program of monitoring. For others, the greatest logic lies in a "group-group" basis of measurement. Looking for a parallel, one MPO planner noted that his studies of transport pricing were first focused by facility, then recast to examine user groups, and next year will be disaggregated to the level of the individual traveler. He argued, "*The real data at the local level is the personal vehicle; not the network, not the system, not the user group."*

Another approach came from a state official, who argued that the best way for the process of measurement to be of actual help in the political process is to examine the market groups, particularly those helped and hurt by a given policy decision. He would argue for the creation of objectives by market group:

> *From a policy perspective, we are market-oriented; we look at the market group impacted. This establishes market needs through objectives ... the market groups approach helps you understand political implications...*

He notes that a pure cost benefit calculation would "send all money to the urban areas, and we do not do that." He argued that we define the specific market groups we want to serve, and we serve them. But, we do in fact differentiate between market groups and treat them separately:

> *In the selection of projects we need to disaggregate benefits...While all persons are valued the same, we break out some for specific attention. In Puget Sound, we voted for light rail, preferring the needs of the downtown commuter. We put higher weight on one set of users' considerations than on others.*

This philosophy of planning for distinct market groups would have implications for the development of performance measures for freight. While many measures have been proposed that look at some characteristic of the freight being carried, such a total weight, total volume, or even total value, this approach would ask given freight shipment was key to the economic generation of the local economy.

In the example that the managers discussed, a developer might come to the state and ask for an investment in a road going to a proposed new shopping center. At the same time, Boeing might come to the state and note that a key roadway was a bottleneck in its just-in-time delivery system. Historically, the shopping center road would be described as serving new development, while the existing bottlenecked road was seen as an issue in the maintenance of the existing system.

Under this approach, an investment in a shopping center would be seen as an investment that redistributes economic growth, (i.e., the relocation of retail sales from one shopping center to another) as opposed to the generation of economic activity. Alternatively, investment that supports basic economic activity, whether that is apples or jet planes, would be classified and examined under the concept of a generative investment.

■ 6.4 Integration of Disaggregate Data into the Planning Process

Much of this discussion brings to a full circle the discussion of the value of a disaggregate data source such as EWITS. By knowing what is in a truck, the urgency of a capital investment geared to improve the quality of travel for that truck can be assessed. EWITS, with its profound understanding of the logistic chains for each commodity, would help the decision-maker differentiate between a delay in the shipment of grain, which is not time sensitive, and a delay in the shipment of hay, which emerges from the analysis as totally time sensitive. Data bringing forth such deep understanding of the needs of the commodity being transported have never before been available to support the needs of the decision-maker. Facing a serious public policy crisis like the closing of the Snake River, the decision-maker needs both the power of aggregate observation (the nature of congestion on the system and the condition of the system), and the detail of the disaggregate data about the needs of the grain or the hay. The integration of EWITS data into the statewide planning process will make this possible.

6.5 Use and Misuse of Measures in Decision-Making

Several of the practitioners we interviewed expressed the concept that rigid application of quantified measures could have a harmful effect on the decision-making process. The temptation to apply quantified measures, as opposed to forming a qualitative policy decision, is seen by some as a potential problem with measurement. Looking at the decision to fund all-weather roads, one manager noted:

> *Multiple criteria help judgments. All-weather roads did not come from level of service; not from congestion. It was because people wanted to move! So we chose to segregate by category – and treat it under a different objective. We decided from a data free policy approach!*

At the MPO level, one planner noted that the agency should not go down a path of finer and fine quantification of set of measures:

> *We are doing other things besides measuring qualitatively and numerically. We are looking for multiple benefits. For example our grade crossing program looks at community impacts, train safety, queuing times, and land acquisition. It is the composite nature that we want to look at; not increased quantification of efficiency measures...*

The manager of the freight planning process at the MPO ended the interview by pointing out that the future of performance measures will be determined by needs of the political process, and that we need to structure a process that can deal with the reality of that uncertain future.

> *What are the flags to look for to track uncertainty...The kinds of information needed will be revealed by actual political decisions you want to make. Do not let the data drive the issue; make it responsive to decision-making needs...*

Another MPO planner supported this:

> *We are looking for a thoughtful process of knowing choices: performance measures are not a word used here ... performance measures should not drive the decision.*

7.0 Experience and Lessons

This case study focused on system performance as it related to freight movement. Experience with similar types of studies showed that when freight stakeholders are brought into the process, the resulting performance-based planning process effort becomes quite meaningful. However, a freight focus also raises the question of how user-specific transportation issues that are important to specific groups can be generalized to those who are responsible for the entire system. The specific observations that result from this case study include:

- Transportation system performance can be viewed through a user-based or a facility-based perspective; these perspectives were illustrated in this case study through data aggregation on horizontal or vertical scales, respectively. Both perspectives are valuable to different scales of performance-based planning.

- A disaggregate approach to transportation planning would tend to look at the characteristics of many smaller units of user groups. This is an issue of increasing importance as transportation investments are expected to be more responsive to issues of larger societal interest. For example, in the air quality area, understanding the nature, timing and characteristics of a trip that involves a cold start might be more important than understanding a trip when no cold start is involved.

- The level of performance measure disaggregation will be related directly to the type of information desired. Even within a user-based perspective, the selection of individual user-based, commodity-based, or market group-based measures depends ultimately on the types of decisions to be made based on this information.

- Case study participants cautioned that an agency should resist temptations to define a finer and fine set of measures.

- A disaggregate user-based approach like EWITS provides an additional tool for assessing qualitative policy decisions. Washington State's investment in all-weather roads illustrates the increasing analytical need in this area.

- As in other cases, the Washington State case shows the concern with having performance measures replace decision-making in establishing priorities. Such prioritization is considered the purview of the political process, and a planning process needs to respect this differentiation.

- Washington State shares the perspective of the Oregon and Florida DOTs that performance measures should be differentiated from condition indicators. To Washington State, a performance measure should be causally linked to agency objectives and actions.

Case Study: Vermont AOT

1.0 Overview

The Vermont Agency of Transportation (AOT) has set in motion a program to monitor the performance of the programs aimed at improving the quality of transportation in the state. The program is based on both agency commitments and a specific legislative mandate to undertake a program of monitoring and feedback in the planning process. Specifically, the legislature has mandated a program of monitoring the performance of the system. In the process of creating the agency budget, the law mandates the documentation of inputs (state funding), outputs and outcomes. The law calls for the creation of an "Agency Strategic Overview," for every executive branch agency, covering each programmatic area. The agency undertook a customer survey as part of the long-range planning effort in 1994, and is working on methods to continue meaningful communication with the customers of the agency.

Senior managers at the agency reported satisfaction with the development of a program to monitor the outputs of the agency's work, but are just now wrestling with the transition to the use of outcomes. In order to approach the concept of outcomes, the manager of the overview process tells each of the responsible program mangers to "try to envision what would you see if your program was totally successful; then, what would be the indicators to use to see if you have accomplished what you set out to do." Importantly, this jump to outcomes has not yet called for the quantification of mobility in transit, rail or aviation.

2.0 The Vision, Mission, and Goals of the Agency

This section presents the vision and mission of the Vermont AOT, which serves as a foundation for their planning process.

> *The Agency's Mission is to maintain a transportation system that allows for the safe movement of people and goods in a cost effective, environmentally sensitive and timely manner.*
>
> *The Agency's vision is to preserve and improve an integrated transportation system to support the Vermont way of life and economic vitality.*

To accomplish its mission and vision, the agency is committed to working towards the following goals:

- Support and maintain Vermont's transportation system and promote efficient operations of that system;
- Promote and support the use and connection of appropriate forms of transportation;
- Support Vermont's economy by providing appropriate transportation access to all areas of the state;
- Cooperate with Vermont residents, towns, regions, other state agencies and interested parties in making transportation decisions that balance the needs of the human and natural environments;
- Seek adequate and stable funding and staffing to support mission requirements;
- Provide employee training and skills enhancement to build a strong, professional work force;
- Encourage and recognize innovation, flexibility and excellence; and
- Foster communication and promote teamwork.

3.0 A Program of Monitoring and Feedback

During interviews for this case study, the managers of the Agency Strategic Overview for transportation discussed the development of this program to enhance the quality of information describing system performance, and more specifically, the performance of the programs funded by, and under the review of the legislature. In those interviews, the managers discussed those programs that have easily adapted to the needs of a performance-based approach, and those programs that are proving to be more challenging. For example, there was wide agreement in the interviews that programs giving wide latitude to local communities to determine local investment priorities were exceptionally difficult to track through a fixed set of measures. On the other hand, progress in monitoring the roadway, pavement, and bridge conditions were considered major successes of the program to date. As noted below, the agency has placed a high priority on the application of similar forms of condition monitoring to the maintenance program.

3.1 Measuring the Condition of the Roadway

Most of those interviewed suggested the program of monitoring for statewide roadway conditions was a good point of departure for the program. Table 3.1 shows the result of the condition monitoring undertaken between the years 1964 and 1991. The roadway system is subject to a program of performance evaluation in which:

> *The Agency collects information on the traffic patterns and volume, pavement and subsurface conditions, accident history, bridge conditions and construction activity, and uses it to develop an indicator that reflects the overall condition of the system. This indicator is called the roadway sufficiency rating (RSR). It is comprised of three parts: 1) structural condition, 50 percent, 2) safety, 25 percent, and 3) service, 25 percent. A rating between zero and 40 places a roadway segment in the "bad" category, between 40 and 60 in the "poor" category, and between 60 and 80 in the "fair" category and between 80 and 100 in the "good" category.*

In its application, the benchmarks call for greater than 80 percent of the Interstate system to reach the "good" category, and for 35 percent of the arterial highway system to reach the good category and 30 percent of the collector highway system to be rated as good, as summarized in Table 3.2 for all highway systems.

Table 3.1 Monitoring Roadway Conditions in Vermont
Program Performance

	Statewide Roadway Conditions											
	Interstate System				Arterial Highways				Collector Highways			
Year	Good	Fair	Poor	Bad	Good	Fair	Poor	Bad	Good	Fair	Poor	Bad
1991	86.3%	13.7%	0.0%	0.0%	10.7%	30.6%	44.8%	14.0%	4.2%	27.1%	50.5%	18.2%
1987	89.4%	10.6%	0.0%	0.0%	16.8%	34.6%	37.0%	11.6%	6.6%	34.7%	40.7%	18.0%
1983	99.1%	0.9%	0.0%	0.0%	21.0%	38.1%	31.1%	9.7%	14.3%	39.9%	33.0%	12.9%
1979	100.0%	0.0%	0.0%	0.0%	22.0%	31.6%	32.6%	13.8%	25.1%	37.2%	28.7%	8.9%
1976	100.0%	0.0%	0.0%	0.0%	20.3%	33.4%	30.7%	15.6%	24.3%	33.7%	29.4%	12.6%
1972	100.0%	0.0%	0.0%	0.0%	27.3%	28.8%	29.1%	14.8%	33.8%	26.7%	26.7%	12.7%
1968	100.0%	0.0%	0.0%	0.0%	33.2%	24.5%	27.8%	14.4%	44.9%	18.7%	23.7%	12.7%
1964	100.0%	0.0%	0.0%	0.0%	36.5%	23.9%	27.1%	12.5%	46.6%	20.4%	21.1%	11.8%

Note: Statewide road conditions are addressed in both the roadway *and* paving programs. Paving is intended to stem deterioration and protect roadways in the "Fair" and "Good" categories, while the roadway program addresses the worst of the locations suffering from safety, capacity and structural problems in the "Poor" and "Bad" categories.

Table 3.2 Benchmarks for Roadway Condition in Vermont

System	Good	Fair	Poor	Bad
Interstate	>80%	<20%	0%	9%
Arterial	>35%	>30%	<25%	<10%
Collector	>30%	>25%	<30%	<15%

3.2 Measuring the Condition of Pavement

Senior agency managers believe that the pavement program has evolved away from a list of projects, conceived of a separate project, to a system which can be described, evaluated and understood. In the view of these leaders, this is a major breakthrough, associated with the understanding of a system of monitoring and feedback on the conditions of the system, and the performance of its managers in improving that system.

The program of monitoring the condition of the pavement system has been created to merge several kinds of data in the summary description of pavement condition:

> *Program performance can be assessed by measuring pavement cracking, rutting, and roughness, and comparing the condition of the highway surface to a standard. One program goal is to have no more than 20 percent of the vehicles miles traveled in poor condition, and another is to have the average condition of all vehicle miles traveled greater than 60 on a scale from 0 to 100.*

Table 3.3 presents pavement condition targets through the year 2006.

Table 3.3 Monitoring Pavement Conditions in Vermont

	Projected Monitoring Pavement Conditions in Vermont									
Category	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
Good Condition (%)	19	18	19	22	25	31	34	34	26	35
Fair Condition (%)	27	22	17	18	17	18	17	19	22	28
Acceptable Condition (%)	35	30	31	26	21	17	18	16	14	11
Poor Condition (%)	18	29	33	34	36	35	31	31	28	25
Avg. Condition Rating	61	65	52	52	52	53	55	56	58	60

3.3 Monitoring Bridge Condition

For the bridges on the Interstate system, the program seeks to identify conditions that would later develop into being structurally deficient. For the state's bridges located off of the Interstate system, the agency intends to reduce those in the structurally deficient category to less than 5.0 percent, at a rate of 1.4 percent of bridges per year. The benchmark calls for reducing the number described as functionally obsolete to less than 10 percent of the system, reducing them by .5 percent per year. The specific goal here is to improve all six bridges that are now posted for less than the legal weight limit. Concerning the problem of town-owned bridges, the benchmarks reflect an increased challenge associated with the older locally owned facilities: the benchmark calls for holding the number of functionally obsolete structures at less than 15 percent of the total bridges. For structurally deficient bridges, the benchmark calls for reducing their number to less than 5.0 percent of the total system. Table 3.4 summarizes current and projected bridge conditions.

Table 3.4 Monitoring Bridge Conditions in Vermont

	Statewide Bridge Conditions					
Category	**1995**	**1996**	**1997**	**Projected 1998**	**Projected 1999**	**Projected 2000**
Interstate Bridges						
Acceptable Condition	65.5%	65.5%	70.3%	70.2%	70.2%	70.2%
Functionally Obsolete	33.9%	33.9%	28.1%	8.1%	28.1%	28.1%
Structurally Deficient	0.6%	0.6%	1.6%	1.7%	1.7%	1.7%
State Owned (Non-Interstate) Bridges						
Acceptable Condition	62.2%	63.6%	68.5%	70.4%	72.3%	74.2%
Functionally Obsolete	17.9%	18.1%	14.1%	13.6%	13.1%	12.6%
Structurally Deficient	19.9%	18.3%	17.4%	16.0%	14.6%	13.2%
Spans Posted for Weight Limitations	10	8	6	6	5	4
Town Owned Highway Bridges						
Acceptable Condition	51.2%	50.9%	53.9%	56.7%	59.5%	62.3%
Functionally Obsolete	18.1%	17.5%	16.7%	16.2%	15.7%	15.2%
Structurally Deficient	30.7%	31.6%	27.1%	27.1%	24.8%	22.5%

3.4 Developing a Performance Monitoring System for Maintenance

The Vermont Agency of Transportation is now in the process of applying the process of performance monitoring to the critical activities of the maintenance department. The agency is now "developing a new survey tool to more effectively track and survey our customer's feedback." In 1997 maintenance developed a customer log to track complaints. The maintenance department is designing a new telephone log system to capture customer requests, developing a mechanism to annually survey district customers, and developing a numerical index to rate maintenance conditions for road sections. The system of measurement will quantify maintenance performance from customer surveys, district input, safety, and other factors. The agency is attempting to decentralize aspects of decision-making for maintenance, established a minimum and maximum acceptable level of product, and then allowing the districts to fashion policies consistent with their budgetary allotment. In this program "the Districts will be held accountable to stay within their budget and appropriately balance their human and financial resources."

3.5 Monitoring the Performance of the Rail Program

In the rail area, the performance tracking system monitored the follow areas of rail performance:

- Number of rail/highway crossing rated above 70, (on a scale which takes into consideration warning systems, approach geometrics, and identifiable hazards);
- Percentage of the state-owned track that is improved; and
- Passenger rail ridership for both of the states subsidized Amtrak services and freight tonnage hauled.

Table 3.5 summarizes this rail system monitoring program.

Table 3.5 Monitoring Rail and Aviation in Vermont

Category	1994	1995	1996	1997	1998	1999	2000
Rail Performance Data*							
No. of Rail/Hwy Xings rated >70	–	392	395	396	401	413	263
No. of Rail/Hwy Xings rated <70	–	284	281	280	275	270	263
State-owned track improvements (% of system)	–	5%	5%	10%	10%	10%	10%
Passenger rail ridership (The Vermonter)	–	66,435	70,000	73,500	78,000	82,000	86,100
Passenger rail ridership (Ethan Allen Express)	–	N/A	N/A	34,000	35,500	37,500	40,000
Freight tonnage hauled	–	2,415,051	2,100,000	2,400,000	2,520,000	2,650,000	2,800,000

*Note: Projects based on previous performance and program manager estimates.
Ridership based on an annual period beginning April 1.

Table 3.5 Monitoring Rail and Aviation in Vermont (continued)

Category	1994	1995	1996	1997	1998	1999	2000
Aviation Performance Data							
Reported air incidents	7	16	10	12	12	12	12
Annual airport revenue	$135,700	$178,800	$173,600	$157,000	$160,000	$170,000	$180,000
Statewide enplanements	444,700	424,900	444,600	418,500	450,000	455,000	460,000
Rutland enplanements	3,200	3,700	3,000	2,700	4,000	5,000	6,000
Airports with freight service	N/A	N/A	4	4	4	5	5
People directly employed at state airports	N/A	N/A	N/A	92	110	115	120

3.6 Monitoring the Performance of the Aviation Program

The performance report of the aviation program spells out the objectives being served by the program and the measures used to track system performance. The objectives of the aviation program noted along with measures included in the Agency Strategic Overview:

- Increase airport safety (measure is reported incidents);
- Promote statewide activation education and awareness (no measure stated);
- Optimize the system capacity (addressed in aviation system planning programs);
- Promote statewide air passenger travel (statewide enplanements); and
- Promote air freight service (number of airports with freight service and number of people directly employed at State airports).

The program to track aviation program performance is presented in Table 3.5.

3.7 Tracking the Performance of Public Transit

The goals and objectives of the state's Public Transit program are expressly included in the Agency Strategic Overview, allowing the reader to note the relationship of the measures selected with the overall program purpose. The program goal "is to encourage and promote statewide public transportation and to coordinate specialized transit services with public transportation where appropriate."

The program *objectives* of the state's Public Transit program include:

- Improving services for the transit dependent;
- Developing full service systems;
- Improving public transportation effectiveness through innovation;
- Developing systems providing linkage between modes;
- Increasing public awareness of available choices; and
- Promoting new facilities and services that meet needs of communities.

The program *benchmarks* include a policy to attain:

- A 5.0 percent increase in public transit;
- A 2.0 percent increase in ridematch; and
- A 2.0 percent increase in carpooling.

As shown in Table 3.6, the items tracked include number of public transit riders, new transit organizations in that year, rideshare program rides, number of individuals carpooling, and miles of fixed route vehicles in operation.

Table 3.6 Monitoring Transit performance in Vermont: Public Transit Performance Data

Category	1995	1996	1997	1998	1999	2000
Statewide Pub Transit Readership (millions)		2.27	2.31	2.56	2.69	2.92
New Public Transit Organizations						
Rideshare Program Rides (thousands)	64.5	70.3	63.7	64.9	66.2	67.5
Number of Individuals Carpooling	996	1,105	1,357	1,384	1,141	1,440
Miles of Fixed Rt. Vehicles in Operation (thousands)	N/A	1,983	2,734	2,789	2,845	2,902

3.8 Local Transportation Facilities

Of all of the program categories discussed in the interviews, it was argued that the State's program to increase local options in the expenditure of locally oriented funds was the most difficult program for which to establish a program of performance tracking. Within this local-funds category, the Agency includes the "Enhancements" program, bike and pedestrian facilities program, park-and-ride facilities, and a local projects program.

The Enhancement Program seeks to encourage a variety of proposals from local communities, and thus, has set as its goal to receive 50 applications and to fund 20 of them, with 50 percent of projects underway in two years.

The Bike and Pedestrian facilities program's goal is to "provide safe and convenient facilities for those Vermonters who desire to use alternatives to motorized transportation." In pursuit of this goal, the program seeks a benchmark of three bike and pedestrian projects constructed in each year. In terms of tracked performance, the program has four projects in construction, with three more expected in the spring.

The Park and Ride Program's goal is to reduce the number of single occupant vehicles on Vermont's roads. No specific benchmark for the appropriate number of new facilities has been set for the program. In terms of tracked performance, the program provided one major upgrading, one new lot, and two more anticipated for construction.

The Local Projects program seeks to transfer responsibility for small-scale project management to the local municipality. The program goals are to "speed delivery and enhance public acceptance of transportation projects." In support of this goal, the program seeks to set objectives concerning new partnerships and exploration of new ways to manage proj??ects. In terms of tracked performance, the agency anticipates that the local municipalities will undertake 15 to 20 programs. Table 3.7 presents program implementation through the year 2000.

Table 3.7 Monitoring Program Implementation in Vermont

Category	1995	1996	1997*	1998**	1999**	2000**
Applications Received	65	61	46	50	50	50
Awards Made	25	24	19	20	20	20
Projects Completed	N/A	5	2	35	30	25

* Process initiated to screen ineligible activities.
** Estimates based on past performance and program manager estimates.

3.9 Municipal Assistance

As was discussed in the Florida case study, the process of program evaluation can include a description of transportation system performance on the one hand, and fiscal program performance on the other. For example, if a program goal is established to devote more than 51 percent of roadway funds on maintenance, that policy goal can be tracked by a system of monitoring. While this concept may not involve monitoring transportation system performance in a pure sense, the concept is still of interest to this research effort since interest in program monitoring continues to grow at state and local decision-making levels.

Within the overall program track of municipal assistance, four program elements are tracked in the Agency Strategic Overview. *Town Highway Grants* are based on the relevant highway mileage in each municipality, as a portion of the total authorized by the legislature. The *Town Highway Bridge and Culvert Program* is funded with 90 percent state contribution, but managed by the local town awarded the grant. The Town Highway Resurfacing program is funded with two-thirds state funds, but managed by the local municipality. The Technical Assistance Program provides help in planning, engineering, construction, maintenance and legal advice.

Table 3.8 shows the current and projected levels for these programs, based on the assumption of level funding of the programs by the legislature.

Table 3.8 Monitoring Local Aid Levels in Vermont

	Municipal Assistance Levels				
Category	**1996**	**1997**	**1998***	**1999***	**2000**
Town Hwy Grants	$24,452,000	$21,252,000	$21,252,000	$21,252,000	$21,252,000
TH Bridge & Culvert	91	96	95	95	95
(# Projects Funding)	$ 1,934,200	$ 2,250,000	$ 2,250,000	$ 2,250,000	$ 2,250,000
TH Resurfacing	118	154	170	170	170
(Miles Paved/Funding)	$ 2,206,242	$ 2,500,000	$ 3,625,000	$ 3,625,000	$ 3,625,000
Technical Assistance (Funding)	$ 284,200	$ 260,000	$ 260,000	$ 260,000	$ 260,000

4.0 Experience and Lessons

The Agency has set in motion a monitoring process for both system and program performance with the intent of improving the quality of transportation in the state. The program reflects agency commitment as well as legislative directive to undertake a monitoring and feedback program in the planning process. The major conclusions from Vermont's implementation of this program include:

- The Agency has had success instituting monitoring and feedback processes in areas that have been "traditional" agency functions (e.g., roadways and pavements). The Agency has had less success defining measures and designing monitoring systems in newer functional areas, such as programs that give funding authority to local areas.

- The Agency has found it necessary and helpful to modify data collection and manipulation systems to better suit the information demands of a performance-based approach. This modification has included incorporation of user-based elements such a statewide customer survey and an ongoing telephone log system to capture customer's maintenance requests.

- The Agency uses benchmarks within each program area to help align agency actions and select individual projects (in certain cases). The monitoring and feedback programs relate directly to the benchmarking system.

Case Study: Amtrak

1.0 Introduction

Amtrak has been measuring and using monthly customer satisfaction performance measures for three years by collecting data and tracking 13 core measures. While the original intent of Amtrak's Customer Satisfaction Tracking System (CSTS) was to develop a standard customer satisfaction indicator for use by the Board of Directors, these measures are now used throughout the company to shape operations and motivate personnel.

The performance measures that are collected by the Corporate office are distributed throughout the organization. Most of Amtrak's managers use this system as a tool for motivating performance and shaping management decisions. However, the extent to which this tracking system is used varies greatly among the management units based on the support of individual managers for the CSTS and their capacity to evaluate and use the data. The CSTS is not without its critics; some have questioned the overall utility of using performance measures, while others have criticized the validity of certain technical components of the System.

This case study will review the use and effectiveness of Amtrak's CSTS for shaping decisions. It will examine all aspects of the CSTS including the varying levels of buy-in and use of the CSTS, as well as a review of current efforts to improve the CSTS.

2.0 Impetus for Developing CSTS

Amtrak has been struggling to become profitable since it was created in 1972. Beginning in late 1993, new management began to implement several strategic practices such as streamlining the management structure, decentralizing operations (by putting management responsibility closer to the customer), developing a strategic plan, identifying capital needs, and focusing on the need for additional capital. A major part of the management's overall effort to think strategically about its business practices was the development of a Customer Satisfaction Tracking System (CSTS) as the focus of customer-driven management practices for operations and capital decisions.

3.0 Process

In December of 1993, Amtrak chartered the CASH (Customer Attitudes Shall be Heard) Team to prepare and recommend a plan for collecting and communicating customer data to Amtrak management. The Team consisted of individuals from throughout Amtrak's management and worked closely with three customer survey vendors.

Over a period of several months, the CASH Team developed a customer satisfaction tracking program and created a long-term strategy for measuring the revenue impact of service quality progress. According to the CASH proposal, it was expected that the CSTS would "enable Amtrak to quantify the return on investment to improve various service factors and serve as a framework to prioritize management actions." The Team proposed that the customer satisfaction performance measures be integrated into Amtrak's strategic planning process.

Based on this plan, the team recommended that a baseline study be conducted to determine the key drivers of customer satisfaction. Amtrak hired the firm, Technical Assistance Research Programs (TARP), to conduct this survey as well as the ongoing surveys of the major customer satisfaction factors. Using an intensive survey of more than 10,000 customers and a list of 80 issue areas, TARP identified the 13 factors that are most important to customer satisfaction. These factors are as follows:

- Customer Satisfaction Measures;
- Schedule convenience;
- Smoothness/comfort of ride;
- Onboard personnel courtesy/helpfulness;
- Comfort of seat;
- Onboard air temperature;
- On-time performance;
- Complaint handling;
- 800# wait time for agent;
- Bathroom cleanliness;
- Information given about delays;
- Bathroom odor;
- Baggage assistance; and
- Food quality.

In the fall of 1994, TARP began surveying customers from each of Amtrak's product lines on a regular basis. Each month, Amtrak customers are surveyed by mail to measure customer satisfaction in all 13 core issue areas and two overall customer satisfaction measures (overall satisfaction and inclination to recommend Amtrak to others). A copy of this survey is attached in Appendix A1. TARP uses a three-month rolling average of these survey responses to report customer satisfaction levels to Amtrak.

In 1995, Amtrak was divided administratively into three strategic business units (SBUs) to bring operations decisions closer to the point of service delivery. Each of the three SBUs is responsible for several product lines (PLs). Product lines are routes or even individual trains designed to serve certain markets. For instance, the Northeast Corridor includes the Empire, High-Speed Rail, Keystone, Metroliner, and Northeast Direct lines. Since the new administrative structure has been in place, customer satisfaction figures have been distributed to managers throughout Amtrak, in addition to the Board of Directors. It was expected that managers would use these figures at their discretion to shape their operations. The system of distributing and using customer satisfaction measures by the SBU and PL managers has continued since 1995 and was reevaluated for the first time in June of 1997 when the Customer and Corporate Communications group at Amtrak's Corporate offices endeavored to determine the usefulness of these measures.

4.0 Resulting System

The monthly TARP surveys are conducted by mail with a sample of customers who used reserved tickets on Amtrak trains. The survey typically captures responses from at least 30 customers from each train route. In addition to the 13 core customer satisfaction questions that were identified in the baseline survey, TARP calculates a Customer Satisfaction Index (CSI) by averaging the values of customer responses to just two general questions: overall satisfaction with the trip and whether the customer would recommend traveling on Amtrak to a friend or business associate. The fact that the CSI does not incorporate the 13 core customer satisfaction scores has caused some concern that it does not accurately reflect customer satisfaction that can be directly linked to Amtrak performance.

Because the CSTS was originally designed for general Corporate management use rather than frontline management decisions, emphasis was originally placed on the CSI measure instead of the more specific 13 core customer satisfaction measures. This has remained an important measure throughout Amtrak because the Board of Directors and other Corporate officers have continued to place an emphasis on the CSI. However, with the responsibility for the management of trains shifted to the SBUs, the 13 core measures of the CSTS also have become more important as a management tool. These measures are now being used by many of the managers in the SBUs in order to focus their management decisions on customer concerns. For example, a manager might make changes in his cleaning service if bathroom cleanliness scores are low or declining.

4.1 Distribution of TARP Data

The CSTS measures are distributed throughout corporate headquarters. The CSI for each of Amtrak's product lines is included in the Amtrak Board of Directors quarterly report. The CSI, along with the 13 core customer satisfaction measures, is incorporated into Amtrak's strategic plan and reported to the President of Amtrak.

In addition to use at headquarters, the information collected in these surveys is provided to business unit market research managers at all three SBUs in the form of raw data, quadrant reports, histograms, line charts, and cross-tabulation tables. While the raw data come directly from TARP, the Corporate office also distributes an extensive monthly report of tables, graphics, and analysis to all SBUs. An abridged sample of these reports is included as Appendix B.

The CSTS raw data and corporate reports are used in different ways and to different extents within each SBU. Based on interviews with market research and product line managers from all three SBUs, it is clear that the use of the CSTS varies greatly among these individuals because of differences in need, ability to interpret the data, and perceived usefulness of the information. The following are brief descriptions of the ways in which the customer satisfaction measures, also referred to as TARP scores, are currently distributed to and used by the market research and product line managers to motivate PL management and personnel.

Administratively, the three SBU market research managers provide research support for all of the product lines in their SBU. Each of these managers distributes and uses customer satisfaction performance measures in different ways. While the Northeast Corridor (NEC) market research manager utilizes these measures in his day-to-day management practices, the other SBU market research managers leave more responsibility to the product line managers for compiling and using CSTS data.

The Marketing Research and Forecasting group of the NEC prepares a monthly report using the raw TARP material and distributes the information to product line managers and other personnel in the business unit. The NEC report includes a matrix of each PL's rolling averages for all 13 core measures and CSI with a bulleted review of the findings. In addition to the distribution of the monthly report, information from these surveys is considered in monthly operations review meetings with all product line managers.

The other SBU market research managers are not as enthusiastic about reviewing and 'packaging' the data at the SBU level. One of these managers does not use the data to develop reports for product line managers; rather he passes the data and corporate reports on to the managers so they can create their own reports. In part, this is because of the limited staffing levels at this SBU, but he also believes that these measures can be used most effectively at the lower levels of management. One way this SBU does use these measures to motivate personnel, is by conducting a contest for the "Train of the Quarter" and "Most Improved Train of the Quarter" based on TARP scores.

■ 4.2 Performance Measure Uses

Once the TARP measures are distributed to PL managers, they are used to motivate performance and shape management decisions, but to varying degrees among the product lines. This case study considers the perspectives of five product line managers in the three SBUs and finds that all of these managers had very different opinions about the usefulness of Amtrak's CSTS. According to one product line manager, the CSTS has "radically changed the customer service approach" and is "critical to establishing customer service excellence." However, another manager referred to the CSTS as "an appendage to management, not a useful management tool."

While all of the PL managers we spoke with distribute some of the customer satisfaction measures to mid-level management and personnel, only three of these managers use the measures as a decision-making tool. And all agree that the CSTS needs improvements to make the CSTS more useful and effective. The following is a more complete review of these findings.

4.2.1 Motivating Personnel

Most product line managers use the TARP scores to motivate personnel because they believe that the CSTS gives individuals a sense that they are meeting customer expectations, and that they can truly make a difference in operations. Many of the PL managers believe that employees understand and use the reports to drive performance because they know that their performance is judged by these measures. However, we could not validate that assumption.

Managers employ several methods of distributing data to personnel. These techniques include posting scores for all trains in the product line on bulletin boards and highlighting key areas for improvement, distributing progress charts to management at regular staff meetings and discussing the results at "service team" meetings, and distributing original graphs of the data to mid-level managers.

While most product line managers use the TARP data to create a unique report for the product line, one manager generally does not even review the thick set of data and tables that are provided by TARP. Instead, he distributes the SBU market research report 'as is' to employees. In direct contrast to the opinions of the other managers we interviewed, this manager does not believe that these measures have any real impact on personnel because most of the people who work on the product line are task oriented, and are therefore unconcerned with corporate objectives.

Even if information is distributed to mid-level managers and personnel, it is unclear whether the data are actually motivating performance. First, it is possible that mid-level managers are not passing the information to lower levels. There is also a concerned that Amtrak has not done a good enough job of educating field personnel on the significance of the CSTS and their own potential to impact the measures. It is expected that this type of training will redirect the focus of personnel from 'task orientation' to customer-service.

4.2.2 Managing Operations

In addition to driving individual performance, we found managers using the CSTS to develop their overall operating plans. Following are examples from several managers.

Most managers use the TARP data to point to customer service problems. For instance, a recent drop in customer satisfaction with train delay and other announcements has compelled one product line to conduct a full review of how they make announcements. Similarly, another manager noticed that the provision of information during train delays reduces customer dissatisfaction. Based on this fact, management directed train operators to provide more frequent and detailed time information to passengers. Additionally, key onboard personnel were issued two-way radios to allow operators and conductors to share pertinent information. The customer satisfaction scores rose immediately after these changes were implemented.

A prime example of how a product line manager has integrated the customer satisfaction data into a comprehensive management system is the case of the Coast Starlight, one of the trains of Amtrak West. The Coast Starlight was showing declining revenues and ridership from 1990 to 1994 because of competition from the airline industry and a declining economy. Part of the problem was that the train was a slow and costly alternative to the low-cost airfares that were entering the market. However, the train trip had some strong assets including a scenic view of the coastline.

The product line manager developed a multifaceted approach to increase ridership on that route by raising customer service and improving facilities to meet customer needs. He started with a program to get personnel involved in the process. It was difficult to get buy-in to begin with because the employees were skeptical that management would really implement this new system. The manager overcame this obstacle by talking to every employee about customer issues and the importance of customer satisfaction. The manager then talked with hundreds of customers in on-train receptions to examine the issues that most concern them.

After they secured employee support for the program and identified key customer concerns, Coast Starlight management and employees implemented an intensive service training program to increase customer satisfaction. This effort was complimented by a variety of other programs such as new lounge cars, dining menus, onboard entertainment, a kiddy car, and more. But the greatest emphasis was placed on providing "guest-friendly service" and a service guarantee.

Throughout this new program, management for the Coast Starlight has continued to use measures of customer satisfaction to gauge their progress. In addition to using TARP scores, they are also distributing comment cards on the trains and have established an 800# comment line. The Coast Starlight has received as many as 100 comment cards per week since they initiated their customer feedback program. By emphasizing customer satisfaction in their comprehensive operating plan, the Coast Starlight has steadily increased both ridership and revenues over the past few years.

One of the reasons that many managers do not fully utilize Amtrak's CSTS is because of real and perceived flaws in the CSTS. Most managers are hoping this system will be improved to suit their management needs. However, one manager has developed an inventive approach to overcoming the limitations of the data. He uses a regression model on the monthly data to isolates the most important characteristics affecting the overall customer service index. He uses these findings on a regular basis to make operating decisions.

■ 4.3 Major Concerns about the CSTS

While most of the managers we spoke with are supportive of Amtrak's CSTS, all note key problems with the current system. Some concerns are about the quality of the existing measures, while others are in regards to their ability to use these measures to drive performance.

"The Measures Have Limited Value"

The CSTS currently has only 13 measures, which were selected from over 80 possible customer service issues. The fact that this system started with a relatively small number of measures appears to have made the information usable and accessible to a large number of company managers. However, as managers have become more comfortable with these measures they are asking for more detailed measures to target specific train operations.

Amtrak managers' fundamental concern with the CSTS is that it can not accurately measure specific customer satisfaction problems. For instance, since on-time performance is a critical factor for customer satisfaction, it is difficult to determine whether score changes reflect on-time performance or actual service deficiencies. This diminishes the value of the CSTS on lines that are not owned by Amtrak and where freight use impacts on-time performance. It is possible that this problem can be remedied by placing less emphasis on general satisfaction measures and focusing more on very specific measures of service.

In a similar vein, several managers are concerned that data fluctuations are not consistent with actual changes in performance and therefore are not sufficient measures of the problems. One manager gives the example of a half-million dollar cleaning program that resulted in no TARP score improvements. He proposes that one possible reason for this is that measures are not specific enough to point to precise performance areas. For instance, if the measure for food quality declines, it is unclear whether the problem was with food taste, cost, service, or cleanliness of the food car.

It appears that several key measures are either missing, too vague, or irrelevant to product line managers or at the SBU level. For instance, 'seat comfort' is a very ambiguous measure since one can never be sure if the response is based on the seat cushion, the seat fabric, bumps on the track, or any other factor that might go into the seat comfort. The question about the 800# is not relevant to PL managers because each individual route has no control over this factor, and the 800# service collects its own performance measurement data. Another concern is that many measures are missing, such as questions about the train stations and the terminal experience. And some believe that too much emphasis is being placed on the Customer Satisfaction Index and not on the more specific performance measures.

"The Survey Form and Process Need Modification"

Managers have also expressed a need to have a more adaptable survey form that can be adjusted to address the unique qualities of each product line and train. For instance, the AutoTrain has no measure of whether customers are satisfied with the car offload time. Also, managers are not currently able to test the effectiveness of new programs by using this system to survey customers on specific issues before and after a program is implemented. An adaptable survey will help Amtrak succeed in its objective to have a system that can truly quantify the return on investment.

Other concerns about the CSTS address the methodology that is used for the survey. First, the sample of 30 customers is fairly small, which may limit the consistency of the responses. Also, the sample excludes all customers who do not ride on reserved tickets. Thus the sample excludes all passengers on unreserved trains and passengers that use an agent or ticketing machine to buy tickets. Additionally, the process for distributing results is too slow for managers to respond quickly to customer concerns. Also, management efforts can not be directed to specific problem trains and personnel because current data are not directly linked to specific train trips.

Another way to make the program more effective is to provide all personnel with guidance on how to interpret and use the data. The most supportive managers have already tried to make sure that their employees have this training, but not all managers have been enthusiastic supporters of this system.

"The CSTS Cannot Stand Alone"

While most managers we spoke with agree that Amtrak's CSTS is a useful management tool, they note that the measures can not stand alone. The TARP scores must be used as one component of a systemic customer satisfaction program. One example is the Coast Starlight, which integrates several customer satisfaction resources including personal discussions with customers and personnel, customer comment cards, an 800# comment line, and TARP measures.

Finally, several managers expressed the concern that they are not able to institute any changes in response to these measures because of a lack of resources. It is unclear to at least one of the managers we spoke with that it is cost-effective to commit resources to achieve higher scores because there has been no real cost-benefit analysis methodology developed to use CSTS data. In fact, one manager wonders whether the shear existence of these surveys is building false expectations in their customers.

5.0 Impact of Performance-Based Planning

Amtrak's CSTS is well established within the company. While some managers express concern about the content of the CSTS, very few question the importance of a customer-driven management system. There is no doubt the CSTS has resulted in the creation of new programs and new management practices. This study has laid out several examples of how managers have developed programs in response to low scores for announcements, customer service, and cleanliness. The Coast Starlight is an excellent example of how these measures can be integrated into an overall management system.

However, other managers have not bought into the CSTS and are therefore not willing to use the information it provides. Some PL managers do not feel empowered to make changes and are not convinced that this is a useful management tool. But even the most cynical managers believe that the current system can be fixed to be useful to managing operations. Most managers believe that the basic structure of this program can remain in place with improvements in the content and use of the measures. Managers have also expressed a need for training all personnel on how to use these measures to shape operations.

6.0 Experiences/Lessons Learned

An overarching problem with this system is that it was not properly adapted to suit the needs of the SBUs when they were established in 1995. The CSTS is still generating very general, systemwide measures that, while useful for establishing an overall perspective of the program, are not detailed enough for use by SBU and PL management. An example of this problem is the continued emphasis on CSI scores that are not reflective of the scores on the more specific measures. The CSI was not developed as a tool for managing day-to-day operations, but for the benefit of the Board of Directors. It is difficult to get management to buy into this system when the system does not provide enough information to meet their needs.

The variation in use of Amtrak's CSTS makes the point very clearly that in order to motivate personnel and shape operations with customer satisfaction measures, it is essential to have buy-in from managers and employees throughout the organization. The level of usage of these measures at Amtrak can be directly linked to whether the SBU and product line managers support the CSTS in their management practices.

One way to assure that this system is used is to include managers in the process of developing and managing the CSTS. Managers that are involved in the process are more likely to use the measures that come out of the CSTS because they will have confidence in their value. It is also important that managers have an opportunity to share their experiences with other managers. In this way, managers can troubleshoot common problems and learn from each other's experiences.

Until recently, managers have been concerned that the Corporate office of Amtrak did not reach out to SBUs in the development of this system and has not been receptive to SBU requests to change. The inclusion of managers in the reevaluation of the CSTS is expected to have the effect of both improving the CSTS and increasing the use of the measurement information.

7.0 Future Plans

The Customer and Corporate Communications group at Amtrak's corporate headquarters is heading up an effort to improve the current CSTS. The group kicked off its efforts with a meeting in June of 1997. Participants at the "Customer Satisfaction Index Data Summit" included representatives of the Corporate office as well as several SBU and PL managers. This meeting identified all of the 'audiences' for this system and how they would like to use the data. They also developed a list of key issues that should be addressed to improve the CSTS.

One concern that was identified at the meeting is that fact that SBUs have had difficulty changing the CSTS survey to suit their needs. This meeting gave managers a forum in which to express interest in improving the survey. It also has opened the door for continued communication between and among managers throughout the company. The primary concern of the SBU and PL managers is that the unique needs of each SBU and PL are not being met by the current survey system.

This group is currently implementing changes in the CSTS to revise the content of the surveys, their approach to surveying customers and their use of these performance measures in reports at all levels in the organization. The Customer and Corporate Communication has already revised the report that goes to the SBUs from the Corporate office. This group is also working with TARP to modify the questionnaire, increase the survey sample size and develop a survey that can be adapted to the unique needs of each train route while maintaining continuity with the core measures.

8.0 Glossary of Terms

Cambridge Systematics, Inc.: Customer Satisfaction Index

The CSI is a key performance measure that is derived from the monthly Customer Satisfaction Tracking System data. This is calculated by averaging the values of customer responses to just two general questions: overall satisfaction with the trip and whether the customer would recommend traveling on Amtrak to a friend or business associate.

CSTS: Customer Satisfaction Tracking System

Amtrak's system for measuring customers' satisfaction with their services. The primary instrument of this system is a monthly passenger survey that measures customer satisfaction with 13 core measures as well as their general satisfaction with the service.

PL: Product Line

Product lines are routes or individual trains designed to serve certain markets.

SBU: Strategic Business Unit

Amtrak was divided administratively into three strategic business units (SBUs) to bring operations decisions closer to the point of service delivery. Each of the three SBUs is responsible for several product lines (PLs).

TARP: Technical Assistance Research Programs

The survey research consulting firm which has helped Amtrak develop, implement and manage their customer satisfaction surveys and compile their data.

9.0 Applicable Source Materials

Customer Satisfaction Scores Monthly. Technical Assistance Research Programs.

Amtrak Customer Satisfaction Survey: Baseline Survey 1994. Technical Assistance Research Programs.

Amtrak's Customer Satisfaction Tracking System Monthly Reports Monthly. Customer and Corporate Communication: Amtrak's Corporate Office.

Meeting Summary: Customer Satisfaction Index Data Summit June 25, 1997. Customer and Corporate Communication: Amtrak's Corporate Office.

Memo to Amtrak West Management Team: Customer Relations Quarterly. Planning and Financial Management: Amtrak West SBU.

Memo to the Coast Starlight Staff: Latest Customer Survey Indicator Report Monthly. The Coast Starlight: Amtrak West SBU.

Memo to NEC Distribution: Customer Satisfaction Scores Monthly. Marketing Research and Forecasting: Northeast Corridor SBU.

A Proposal for a Customer Satisfaction and Measurement Program at Amtrak March 9, 1994. The CASH Team: Amtrak's Corporate Office.

Report of Amtrak Customer Satisfaction Survey Monthly. Customer and Corporate Communication: Amtrak's Corporate Office.

10.0 Contact

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INTERVIEWS

Corporate	Stan Edwards, Project Director, Customer and Corporate Communications
Amtrak West	Steve Roberts, Marketing Manager, Market Planning
	Darrel Johnson, Planning Manager, Market Planning
	Brian Rosenwalt, Product Manager, Coast Starlight
Amtrak Intercity	Doug Varn, General Manager, AutoTrain
	John Wall, Product Manager, Southwest Chief
Northeast Corridor	George Raed, Director of Marketing Research and Forecasting
	Wes Coates, PL Director, Empire
	Dave Nogar, PL Director, NE Direct

Amtrak essentially divided the business geographically: Amtrak West includes operations in California, Oregon, and Washington State; Intercity is based in Chicago and runs all the long-distance trains across the country; Northeast Corridor includes all operations between Boston and Norfolk, Virginia and includes all New England and New York State services.

Case Study: MVRTA (Dayton, OH)

1.0 Introduction

Miami Valley Regional Transit Authority (MVRTA) is the transit operator for the Dayton, Ohio metropolitan area. Its service area encompasses the core of the metropolitan area (all of Montgomery County and the area surrounding Wright-Patterson Air Force Base), but excludes most of the high growth surrounding suburban areas. MVRTA is a medium-sized operator with 250 vehicles including diesel buses, electric trolley buses, minibuses and vans. It operates 25,000 revenue vehicle miles (RVM) on an average weekday, with service provided on some routes up to 21 hours per day, every day of the year. It operates a mix of local, express, suburban, circulator, feeders and cross-town routes (36 routes in total), and is in the process of restructuring services around a new downtown hub and six satellite hub facilities in outlying areas. MVRTA has an annual operating budget of $45 million and a total staff of 680, including about 20 marketing and planning staff.

MVRTA is governed by a Board of Trustees composed of nine members appointed from local jurisdictions. The Board operates via a simple majority vote, except for major finance issues that require a super-majority. The Board is organized around several subcommittees that are responsible for investigating and making recommendations on most matters; most of the major board work is performed through the subcommittees. A 20 to 30 member Citizen's Advisory Committee (CAC) reports directly to the Board and MVRTA staff. The Board created the CAC in the early 1990s to provide a regular channel for dialogue between the community and decision-makers. It is a self-structured committee; there is no fixed membership on the CAC, but attempts are made to assure that major constituencies in Dayton are represented.

MVRTA receives a large portion of their funding (about two-thirds of the annual total) from a one-half percent county-wide sales tax that has been in place since 1980. Combined with farebox returns, about 85 percent of total revenue is locally derived. This funding arrangement provides somewhat of a mandate to intently listen to local customer needs in matters of service planning and operation.

While Dayton is a medium-sized community, it faces many of the development and transportation issues faced by larger areas such as a decentralized population, declining population in its primary service area, and major employment growth outside of its service area. This changing environment, combined with its "mandate" to serve local community needs, created an identity crisis for the agency in the late 1980s and early 1990s. MVRTA needed to find a way to remain relevant in regional transportation, mobility and development discussions.

In spite of these factors, MVRTA had historically tried to operate in isolation from the rest of the community. This situation did not work well in Dayton, where the community had a long-standing expectation to have a voice in community affairs. One of MVRTA's major efforts in the last decade has been to integrate itself into the power and decision-making structures in Dayton. MVRTA went about this integration through the adoption of principles of performance-based planning, and, more specifically, through intensive outreach to the community. This case study reports on MVRTA's evolution towards performance-based planning, with particular emphasis on how customer needs and concepts such as customer satisfaction have been incorporated in the process.

2.0 Process Background

In the late 1980s, severe credibility problems existed for MVRTA management and board members. Agency leaders had deferred major decisions on capital investments, and as a result, a large financial reserve (about $50 million) had accumulated. The community was further displeased with Board decisions to replace the electric trolleys with diesel coaches; this disagreement pointed to a fundamental difference in perspective with the community focusing on community identity and accountability, while agency leaders focused on operating efficiency. Day-to-day management suffered due to a lack of stability in key staff positions. Discussions began in the community to rescind MVRTA's sales tax and reduce its service area. The business community wanted to divert the financial reserve to fund economic development initiatives, particularly in the downtown area.

At the height of these credibility problems in 1991, there was a major turnover in agency management and board makeup. The new leadership felt that community credibility was the most crucial issue facing MVRTA. They immediately convened the *RTA in 2000 Committee* (RTA/2) to provide an external review of what the community expects from its transit agency. The Committee was charged with determining the social, economic and environmental role, as well as level of service, that the community will require from a transit system in the Year 2000.

3.0 Process Development

The RTA/2 committee was composed of 20 key civic, business and constituency leaders. The committee was chaired by a U.S. District Court judge, and included six other government representatives (three elected officials and three local employees), six business representatives (primarily chief executives for major area employers), three representatives from rider groups (transit dependent, seniors, and disabled), and four special interest representatives (labor, education, and two social service agencies). RTA staff was only involved on an as-needed technical basis such as providing background operating information, organizing site visits of peer cities and operators, and coordinating visits from transit system leaders in other communities.

Committee work was guided by a series of "Issue Sheets" in 14 key areas; these papers addressed history; current status; legal, regulatory and budget implications; possible steps; recommendations; and success indicators in each area. Each of the papers took a very serious look at the realities of transit service in light of the external environment.

The committee spent considerable time looking at MVRTA solvency. They developed a matrix of service alternatives versus funding reserve options to help delineate realistic service options and to build a case against funding diversion. This evaluation resulted in definition of realistic options as those that would keep the growth of operating expenses one percent to two percent below growth in sales tax revenue.

The study resulted in community based direction for MVRTA including a set of specific recommendations and four main goals that have guided all subsequent work. The four goals were to:

- Improve mobility;
- Promote and strengthen economic development;
- Maintain solvency; and
- Build public support.

RTA/2 set long-term strategic direction for the agency, but left detailed policy development and management changes to the Board. Results indicated a need for MVRTA to shift from an operations focus to market orientation (pay greater attention to service effectiveness as opposed to efficiency) and to pay more attention to community outreach and accountability. RTA/2 members recommended that the Board be more pro-active in the community and foster higher level outreach with civic and business leaders.

Following completion of the RTA/2 work, MVRTA management initiated a strategic planning process to provide internal restructuring and guidance to address the external recommendations of RTA/2. As a result of this process, a total of 26 specific recommendations and supporting actions were developed to implement the four core goals from RTA/2. A sample of the recommendations and selected actions for the *Build Public Support* goal are presented in Table 3.1. As illustrated in the table, MVRTA did not establish a set of explicit performance measures to assess these strategic actions. During the first phase of the strategic planning process, management has relied on service standards and systemwide measures (see *Major Process Elements* section) to assess their strategic imperatives and goals. This phase of work is currently evolving into a second strategic planning phase that will include specific performance measures for service accountability issues. This second phase, which is discussed below in *Future Plans*, will revolve around a set of customer-defined, quality-based performance measures.

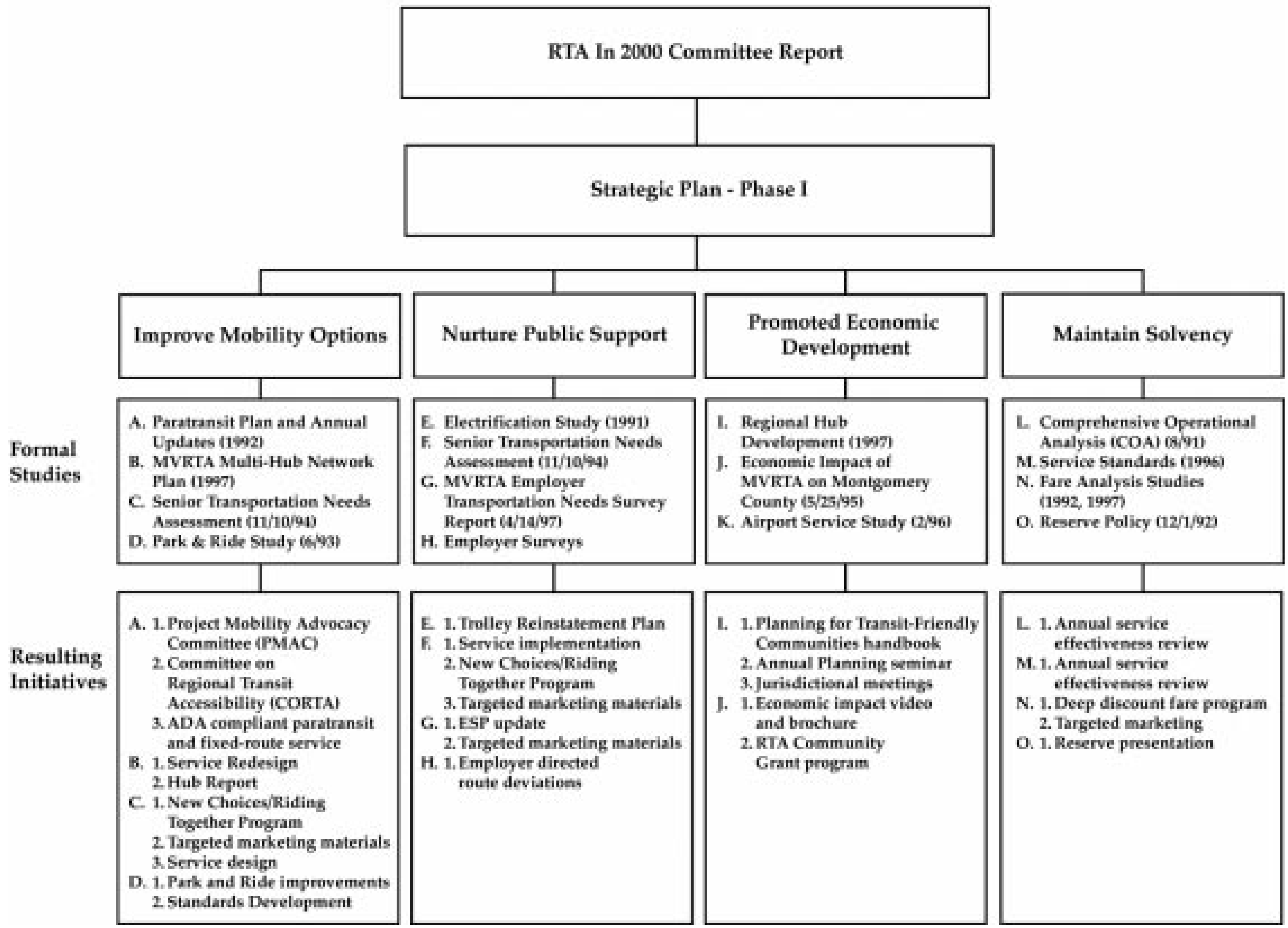
Agency leaders felt that improved agency credibility had to be the first step in implementing the strategic direction. MVRTA management began this step with a directive to face controversial issues head-on. Staff prepared white papers on major issues with several near and long-term options. Management evaluated and selected options through an open process that included long-time critics and key business leaders.

Table 3.1 Recommendations and Actions from Strategic Planning Process

Strategic Imperative	Selected Actions
Increase ridership	
Create positive image	Develop a marketing and PR strategy.
	Initiate a security program.
Seek public participation in planning and policy outreach	Identify and meet with key community groups.
	Strengthen CAC by increasing membership and input opportunities.
	Implement the trolley plan.
Strong leadership and advocacy role for MVRTA in regional transportation planning	Become part of regional effort to provide advocacy for Miami Valley.
	Strengthen relationship with MPO, FTA and ODOT.
Meet needs of target populations	Coordinate services with social service agencies.
	Develop strategy to encourage elderly to use transit.
	Provide service to public schools.
Develop a view of transit as a necessity of life.	(No specific actions)
Provide and maintain effective and efficient mobility options	Investigate alternative size buses.
	Investigate non-traditional financing.

Concurrent with these efforts, several larger studies were completed or initiated to address issues that had been outstanding for several years. Some of the more critical work included an electrification study, a comprehensive operational analysis (COA), re-analysis of service standards, a multi-hub network plan, several fare analysis studies, and an employer transportation needs survey. All of these studies had a unique emphasis and a unique set of performance measures to guide the study. Each also tied into the larger performance evaluation framework established by RTA/2. For example, the electrification study looked at technology, energy and cost issues of different coach types, as well as integration of the options into the overall system plan for service improvements as measured by cash flow, solvency, and public support. Figure 3.1 further illustrates this integration by indicating how each major study and subsequent MVRTA action ties to a specific RTA/2 goal.

Figure 3.1 Integration of Key Strategic Initiatives



4.0 Major Process Elements

The *Process Development* section discussed the initial efforts to re-orient MVRTA to a performance-based organization. The RTA/2 work, strategic planning process, and major studies set the overall framework which MVRTA would need to follow. This section discusses the elements resulting from those efforts that constitute their initial foray into ongoing performance-based planning

MVRTA followed the practice of many transit agencies by implementing an annual service standards process. Service standards provide a framework for evaluating existing service, new service requests, and passenger amenity requests. The RTA/2 committee, MVRTA Board, and outside leaders wanted measurable criteria for justifying service changes and tracking progress in plan implementation.

MVRTA's service standards and other performance measures are illustrated in Table 4.1. The service standards used by MVRTA include passengers per platform hour, vehicle load factors, on-time performance, and community-based service needs. The four service standards are explicitly measured and considered for a route as it undergoes a detailed analysis every four years. The community-based service needs standard is essentially a measure of agency public service; it is a qualitative assessment of fundamental community needs such as access to key employment, commercial or medical facilities provided by a service. It provides a direct link to the "Build Public Support" goal of RTA/2, and is a recognition of the "mandate" arising from local financial support. Table 4.1 illustrates that MVRTA also tracks other systemwide operational measures that had been suggested from the COA.

MVRTA uses both formal and informal means to collect data for the planning process. Formal channels rely on traditional ride checks and fare collection methods of most transit properties. Additionally, MVRTA has an extensive formal outreach program for both target audiences and their overall ridership. One of the first outreach programs of the new management was a "tell us where to go" campaign in the local newspaper in which the community was invited to indicate the destinations they would like MVRTA to serve. The campaign was very helpful in identifying strategies to serve their core constituency and in identifying locations that eventually became satellite hubs.

While they have not performed a broad-based customer survey in several years, MVRTA is planning a major survey effort in 1998 to identify priority issues and establish benchmarks for their evolving customer-based performance measures (see *Future Plans*). The agency has used target market surveys, such as with the senior population in Dayton. MVRTA also used preference surveys as part of the electrification study to present options to affected communities along each corridor; these surveys were effective in gauging sentiment and building support, particularly since the community consensus option differed from the one supported by special interest groups.

Table 4.1 Current Performance Measures at MVRTA

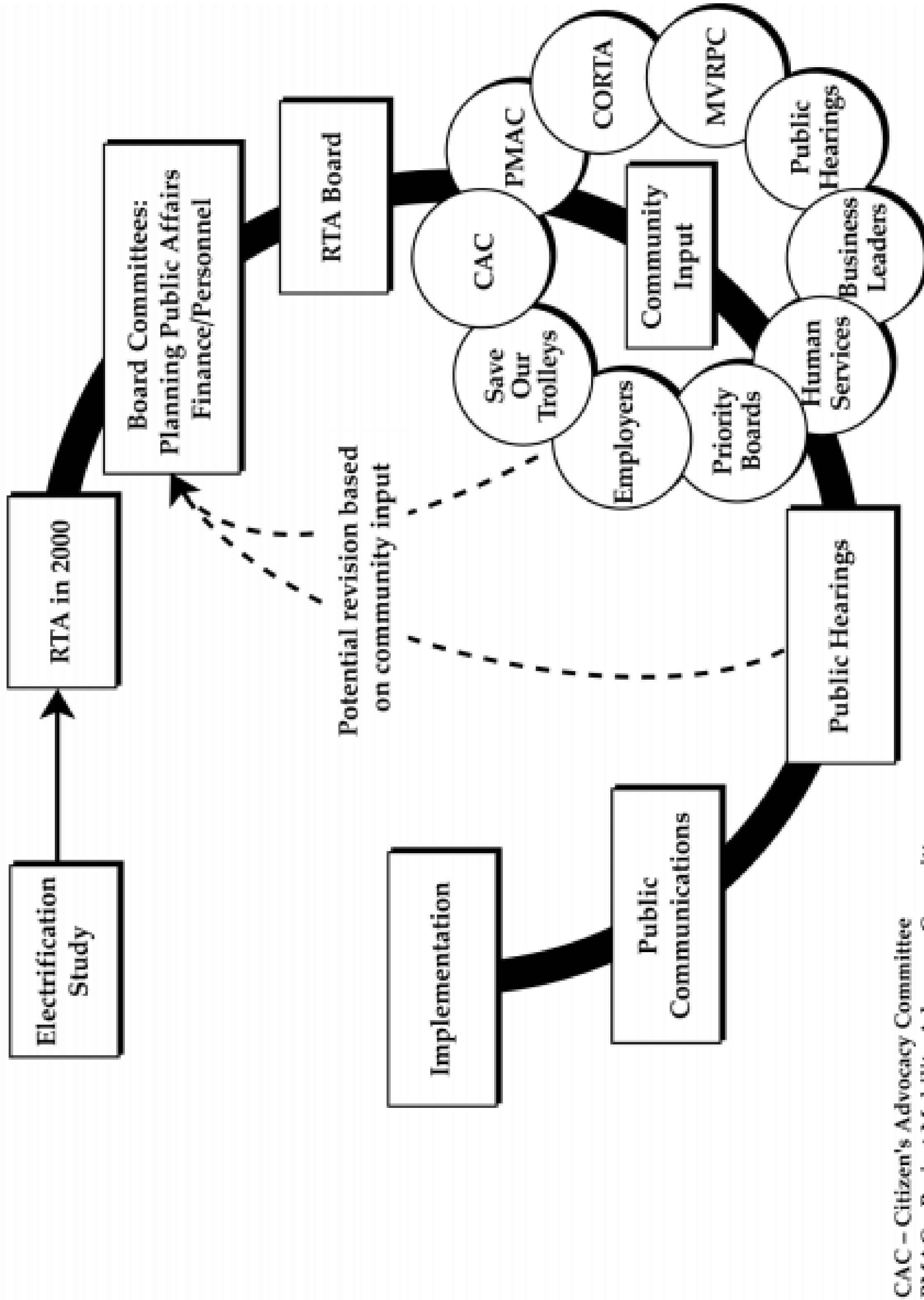
	Application Level		Usage	
Performance Measure	**Route**	**System**	**Service Standards**	**Information**
Passengers per platform hour	✔		✔	
Vehicle Load Factor	✔		✔	
On-time performance	✔		✔	
Community-based service needs	✔		✔	
Passengers per revenue vehicle mile		✔		✔
Passengers per revenue vehicle hour		✔		✔
Passengers per trip		✔		✔
Operating cost per revenue vehicle mile		✔		✔
Layover time		✔		✔
Complaint resolution time		✔		✔

The formal outreach program also includes public hearings, open houses, and open board meetings. MVRTA also staffs a call-in center that is open everyday of the year. The agency widely publicizes the number and invites people to call-in with complaints, suggestions, and any other matter. Staff is required to investigate all complaints received at the center within one week; resolution of complaints is tracked as an operational standard.

The informal data collection program is an extremely important element in MVRTA's outreach. The planning and marketing staff is extensively involved with community boards and groups (civic, business, neighborhood, etc.). Management expects the staff to both provide assistance and input to the groups, as well as invite participation in MVRTA matters. Many of these external groups pointed to the importance of this element in raising the stature of RTA within the community, particularly given the overall level of civic involvement in Dayton. MVRTA's view of the relationship between these formal and informal elements and its internal decision-making is illustrated in Figure 4.1; this figure further ties current activities back to the guidelines provided by the RTA/2 process.

MVRTA has a post-implementation evaluation process that has been growing in importance over the past several years. One element of this evaluation has been reconvening of the RTA/2 committee on two separate occasions to look at accomplishments and suggest further mid-course corrections. A second element is an investigation of major capital projects. An example of this element is the evaluation of the economic development impacts in the area surrounding the new satellite hubs; a baseline investigation has been completed by MVRTA, and will be revisited periodically. A third element of this evaluation is that all new service initiatives are considered experimental due to funding constraints. Under this element, several months of service are followed by period of evaluation. For

Figure 4.1 Relationship Between Agency Outreach and Decision-Making



CAC – Citizen's Advocacy Committee
PMAC – Project Mobility Advocacy Committee
CORTA – Committee on Regional Transit Accessibility
MVRPC – Miami Valley Regional Planning Commission

example, the first six months of service on the senior route were used to establish performance standards (consistent with the agency's service standards) to be met in the second six months of service. After the full year is over, the entire service will be evaluated in terms of the standards and a final decision will be made on making the service permanent.

5.0 Process Impacts

One of the most tangible indicators of MVRTA's successful adaptation of performance-based planning is the fact that their financial outlook has now stabilized. One reason for this outcome is that MVRTA now takes an incremental approach to service upgrades. The agency uses performance-based planning to determine the highest priority needs, and then approaches implementation on an experimental basis incorporating service evaluation and feedback into the process. As an example, two senior-oriented projects, the Ride Together Program (matching a senior with a paid teen escort) and Senior Mobility (a special senior-oriented route two days a week), resulted from their performance-based outreach and evaluation including initial community feelers, identification of major issues and needs, analysis, policy and service options, follow-up surveys, modification of proposal, experimental service, evaluation, and final decision.

In terms of their organization, MVRTA now more closely integrates planning and other functions. Planning staff is responsible for scheduling, and therefore linked to operations. Planning also staffs customer service phone lines twice per month, and is responsible for distributing schedules to distribution sites, providing a link to marketing. MVRTA holds joint meetings of top management from all functional areas. The Board's decision-making process is now much tighter with everyone focused around key issues.

Some of the biggest process impacts have occurred with MVRTA's relationship to the community. MVRTA is viewed inside and outside the agency as more community focused. Many individuals outside MVRTA stated that the agency listens, considers and actually reacts to outside suggestions and desires. One example cited of this outcome was that the final selection of trolley routes and major diesel routes were altered from the "preferred" ones based on community feedback; MVRTA initiated a frank discussion of options and let the individual communities decide which worked best for their situation. The result of this honest outreach is that the community is more willing to support MVRTA in general and for service within specific communities in particular.

MVRTA management admits that the agency used to be an afterthought in the community. However, this is no longer the case as witnessed by several major changes. The agency now has two voting seats on both the MPO board and the downtown chamber. They were integral member of planning and design for a new minor league ballpark in Dayton; pedestrian and transit access were integrated from the earliest planning stages and the Board committed $2 million of agency funds as a match to build these facilities. The Board president is serving on the main National Park Committee planning for the national aviation centennial celebration in 2003; the agency is an integral part of transportation planning for the event while allowing MVRTA to plan and budget for it long in advance.

MVRTA has also become a bigger player in regional and state issues. For example, in response to a recommendation in a recent Economic Impact Study for MVRTA, the agency developed and published the "Planning for Transit Friendly Communities" book as an outreach to the development and zoning community. They followed up publication with two workshops attended by nearly 500 people including developers, builders and representatives from suburban communities. The Ohio Department of Transportation requested MVRTA to repeat the workshop elsewhere in state. MVRTA provides community matching grants (from the agency's own funds) to locals communities to help implement transit-oriented design.

Individuals inside and outside of MVRTA suggest that the agency has become the regional forum for mobility, rather than just a bus operator. MVRTA senior management is solicited to be part of major community initiatives and decisions. They have learned how to target key pieces of information to specific audiences. An example of this is the Economic Impact Study and video developed in 1995 in which the agency focused on return on investment, benefit-cost analysis, and economic impact measures to attract business support. Business community partners have used study results to help lure new investments and businesses to transit accessible areas. The business community now views access to transit as a key competitive issue, especially in getting low-wage, entry-level employees in tight labor market.

These changes in community attitude can be traced to some extent to MVRTA's decision to not make service efficiency the *highest* value for the agency. Instead, community service is closely integrated in their decision-making framework, and is part of their formal service standards process. This value will be further reflected in the annual operations report after implementation of the "Customer First Focus."

6.0 Experience and Lessons

MVRTA's process provides an excellent example of the role that community outreach and agency credibility can play in a successful performance-based planning process. The document reviews and interviews conducted for this case study tended to all point to several common themes that are important considerations in developing a customer focus:

1. Implementation of performance-based planning cannot be treated like an academic study with strict timelines, a set budget and a list of deliverables. It is more evolutionary in nature and mistakes will be made along the way. However, a community that feels involved in developing a proposal will have a vested interest, is likely to take ownership of the results, and will ensure that the ability to implement the plan exists.

2. Stakeholder involvement is a two-way street, requiring that an agency become actively involved in the issues of its partners; simply attending meetings is not good enough. Involvement of senior management and decision-makers is critical for outreach to key stakeholders.

3. Do not bother asking stakeholder and riders for input unless you are able and willing to deliver what they want. Part of reason for MVRTA's gain in credibility was finally paying attention to deferred issues.

4. Controversial issues must be faced head-on. MVRTA's handling of its Downtown Transit Hub Study, in which all issues and local concerns were identified and addressed forthrightly, provides a good example. The agency took ownership of crucial issues and developed a detailed implementation plan to tackle issues.

7.0 Future Plans

MVRTA management has recently begun the second phase of their strategic planning process. This phase will be oriented towards further integrating the agency into regional decision-making. Four initiatives have been developed to guide this phase of the process:

- Creating a customer first focus;
- Promoting economic development;
- Developing a 2003 focus; and
- Enhancing the family friendly workplace.

The "customer first focus" has at its core new benchmarked performance measures that are to become part of the service standards process. The core philosophy underlying this focus is that customer satisfaction is not good enough; instead, MVRTA must find a way to "delight" their stakeholders in order to increase ridership and revenue, and hence be allowed to provide more service. In early 1998, MVRTA will perform baseline surveys of how their riders perceive quality, what are important service issues, and which issues should be highest priority for resource allocation. Customer-based, quality-focused performance measures will be developed and benchmarked; these new measures will supplement operating statistics for marketing/planning, board use and community dissemination. MVRTA sees these measures as one more step in moving the concept of customer focus beyond marketing and planning to affect all facets of organization, particularly in design of services.

As part of this agency-side integration, MVRTA is investigating innovative ways to disseminate information beyond the planning and marketing departments. Agency managers are currently performing a review of peer properties to see how they provide information to all employees, and educate them as to how their actions affect customer service measures.

8.0 Contacts and Source Material

For further information on this approach, contact:

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Dayton, Ohio 45401

MVRTA has produced an extensive backlog of reports and other source material that provide a comprehensive review of their planning process. Some of the more relevant reports include the following:

Multi-Hub Network Plan – Executive Summary; 1997.

Planning for "Transit-Friendly" Communities, May 1997

Senior Transportation Needs Assessment – Executive Summary; November 1994.

Service Standards – 1996.

The Economic Impact of the Miami Valley Regional Transit Authority on Montgomery County: A Quantitative and Qualitative Assessment; May 1995

The Strategic Plan: A Value Added Focus in the 90s, 2000 and Beyond; August 1993

Transit 2000: A Vision of Mobility in Dayton in the Year 2000 – Final Report; RTA in 2000 Committee; April 1992.

Case Study: UPS

1.0 Introduction

United Parcel Service (UPS) is the largest parcel delivery company in the world and one of the largest express and overnight shippers. In 1996, UPS had revenues of over $22 billion, and a profit of nearly $1 billion. UPS was Founded in 1907 as local message delivery company in Seattle, Washington. UPS expanded service offerings to parcel delivery in the 1910s, and began geographic expansion in the 1920s. It became a national parcel delivery company in the mid- to late-1930s. Today, UPS is an integrated information delivery company offering a range of expedited, standard ground, logistics support and information dissemination services across the world.

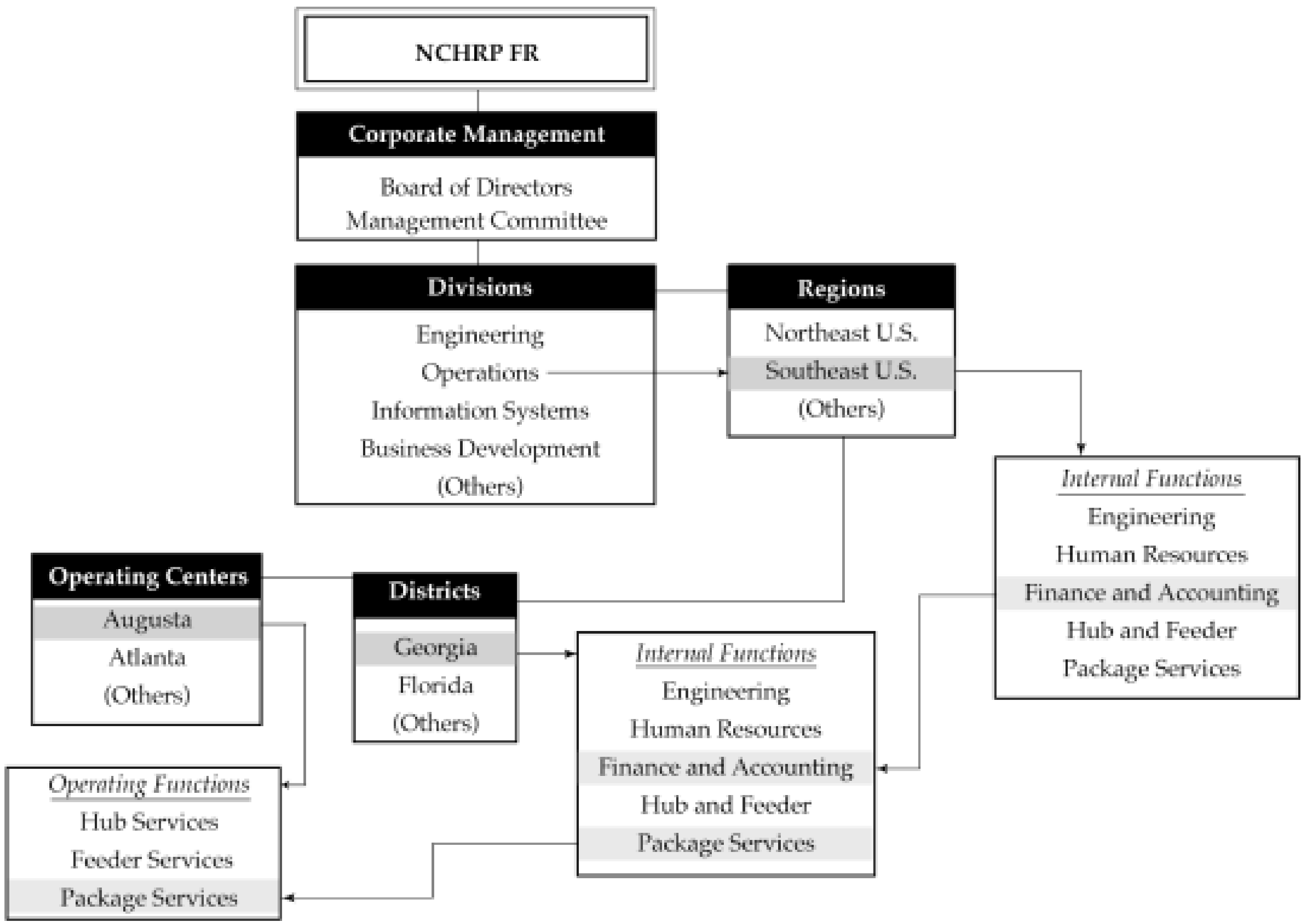
Since company founding, UPS has been privately owned, predominately by management. It is led by a 13-member Board of Directors that until recently did not include any members from outside the company. As of 1997, the UPS Board included the CEO, two former board chairmen, five executive vice presidents, and five individuals from outside the company. There is also a 12-member management committee that is responsible for overall day-to-day management decisions. The management committee is composed of executive vice presidents from the different UPS divisions. The Board and the management committee have relatively well-defined duties with strategic direction set by board and translation of strategic direction provided by management committee.

The board and management committee limit their oversight to major issues of corporate significance. The company tends to operate with relatively decentralized decision-making. UPS' founders tried to direct the company to be both "small" (managers should be functionally close to the decision-making needs) and "big" (management functions geographically decentralized) at the same time. Throughout the company's history, the board and management committee provide direction for this structure through explicit statements of goals and objectives. While this pattern has remained constant, the mechanism for aligning these goals and objectives throughout the company has changed over time.

UPS is organized around several functional groups or divisions, such as operations, international, human resources and finance. Some of the more influential divisions in the operation of UPS' performance measurement system are illustrated in Figure 1.1. The operations division, which is responsible for most delivery activities, is also the primary channel for collecting and influencing performance measures and indices. This division is geographically segmented, as shown in Figure 1.1, into different operating units called regions, districts and operating centers. The package movement occurs through units in the operating centers known as hubs, feeders and package handling. Within the geographic sub-units, there also tends to be a strong alignment along functional responsibilities such as engineering and human resources. This functional alignment extends between geographic sub-units and even into corporate levels. This dual alignment is one factor influencing decentralized decision-making, and helps make the district operating unit critical in linking information flow within UPS.

Figure 1.1 UPS Organizational Structure Showing Functional Alignment for Key Performance Measurement Elements

Using Examples of Geographic Alignment



UPS rapidly changes and adapts its management strategies and measurement systems based on decision-making needs and market forces. This willingness to change approaches is somewhat reflective of the flexibility and needs provided by a private sector environment. It is also reflective of the approach adopted by UPS founders to study other companies for new and potentially better management styles. Through all of these changes, there has been a long-standing culture of measuring performance, particularly productivity. For over 30 years, UPS' performance measurement approach has gone beyond management to include the rank-and-file in measurement and feedback.

UPS' measurement systems have traditionally focused on productivity, efficiency and finance. One of early company leaders was an industrial engineer who embraced the principles of operations research and scientific management; essentially, an unofficial company philosophy was that there was a most efficient way to do everything. Efficiency concerns were a factor in a consistent pattern of goals and objectives oriented towards revenue and volume growth. Early performance measures in support of these goals included volume growth, revenue growth, time-in-transit and cost per package. Profit concerns were not as explicitly assessed in UPS' early systems. In recent years, profit has become a more explicit concern with realization that revenue and volume growth does not necessarily equate to profit growth.

With decentralized decision-making, different corporate-level divisions had historically operated in isolation from each other. This "isolation" included a unique set of performance measures for each division. Alignment of measures across divisions was primarily oriented towards companywide concerns of productivity, service failures and costs. Until recently, customer and employee issues were functionally oriented in Human Resource and Business Development Divisions; these were not considered issues of corporate significance. Several divisions also tended to tended to focus on activities (e.g., participation in training) rather than results (e.g., fewer accidents or delighted customers) in their measurement system.

Within the last five to 15 years, UPS managers have concluded that an exclusive focus on efficiency and finances, particularly volume growth, was creating long-term negative implications especially for fixed asset requirements. This conclusion was based in part on external factors such as industry deregulation and the rapid expansion of competition. For example, new service offerings brought about by competition could not be assessed (and serviced) in same way as traditional ground service. Also, with market forces providing greater leverage to the customer, old actions based on internal productivity concerns (such as package drop-off/pick-up at same time) could not be maintained. Internal assessments also supported this conclusion. Furthermore, it was felt that long-term shareholder value was being hurt by lack of attention to most profitable business segments and to secondary metrics in use at the time.

All in all, many forces have come together to compel UPS to take a broader approach to performance measurement. However, the current approach did not develop from a clean adaptation of prior systems. There were many false starts and changes in plans. As recently as five years ago, the system was considered by some managers to be unwieldy, with 25 measures in use at top levels.

Two main themes are evident in UPS' current and emerging performance measurement system. First, measurement systems within each division are being dropped or aligned in favor of one system tied to companywide goals. Interpretation of measures and selection of actions is still up to management and staff within each division. Second, the measurement systems are moving from a function and activity perspective to a process and results orientation; UPS now defines performance in terms of improving overall product delivery (as indicated through broad metrics) rather than completion of specific tasks. A unique approach to performance-based business planning is emerging from this work. This case study focuses on UPS' performance measures including development, linkage, integration, and usage at different decision-making levels.

2.0 Current Process Focus

UPS uses the concept of *shareholder value* as the ultimate philosophy or driver for their performance measurement system. This concept incorporates many issues tied to the success of both the business and its employees. UPS operationalizes *shareholder value* in corporate-level planning through metrics such as total market value of the firm or the economic value added of an investment or operation. Indices tied to the concept and supporting metrics include revenue, costs, volume and sales growth, return on invested capital and profit

The use of shareholder value as a primary philosophy runs counter to the conventional wisdom of quarterly or annual profit as the ultimate driver for a private-sector company. However, UPS management acknowledges that private ownership removes outside pressure to focus heavily on short-term financial measures. Financial measures are still important and fundamental to the company, but in broader sense.

Shareholder value is an underlying concern in the annual business planning process at all management levels. However, other concepts and tools are more directly used for evaluation and decision-making. One of the these tools is known as the *Balanced Scorecard*, which is based on the work of Kaplan and Norton. The balanced scorecard, as used in the private sector, is viewed as an integrated system of leading and lagging performance indicators tied to strategic objectives of the company.[1] Successful applications of the balanced scorecard tend to be based on an understanding of the relationship among corporate objectives that are at the core of the measurement system. Therefore, a performance measurement system under the balanced scorecard approach not only requires outcome and output measures, but also performance drivers that indicate how strategic outcomes are to be achieved. In other words, a causal linkage needs to be established from the performance measures to the core goals and objectives.

The four elements of the balanced scorecard at UPS are financial, operations (also known as internal business process), customer, and employee. Performance measures that focus on customers, employee skills and internal business processes are leading indicators of financial objectives (a lagging indicator in and of itself). The balanced scorecard concept is used to develop measures within each operating level, and to align measures between levels. The concept underlies performance evaluation at every level in the corporation, with each level having a specific name for its performance evaluation component.[2]

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[1] In this context, a *lagging indicator* suggests how well a company has done in the past while a *leading indicator* suggest how well a company is positioned for the future.

[2] It should be pointed out that UPS Districts use the Balanced Scorecard directly as their performance evaluation component. Therefore, the term Balanced Scorecard refers to both the overall concept of performance measurement at UPS, and the specific evaluation component at the District level.

In spite of the historical importance of performance measurement at UPS, business decisions are not made on a strict interpretation and analysis of individual measures or the broader balanced scorecard. For example, the balanced scorecard is integrated and considered in corporate business planning, but there is always a consideration of more nebulous issues such as macroeconomic conditions, market conditions and competition, and internal opportunities, threats, strengths and weaknesses. In the opinion of UPS managers interviewed for this case study, there will never be a substitute for experience and intuition. However, interviewees suggested that the balanced scorecard provides a common point of departure to assure that experience and intuition of different decision-makers are working towards the same end (shareholder value).

3.0 Process Development

UPS began transition to the balanced scorecard approach about three years ago with identification of the four areas and supporting performance measures to be addressed in their system. The initial balanced scorecard had one measure in each area:

- Customer Service Index (CSI) in the customer perspective,
- Employee Relations Index (ERI) in the employee perspective,
- Operations Report Card in the internal business process perspective, and
- Revenue and Cost Index (RCI) in the financial perspective.

While ERI and CSI had been used in a few operating divisions for several years, the balanced scorecard represented the first time these two measures had been used companywide. According to UPS, the CSI metric had been developed from site visits and focus groups with customers over the past five to 10 years. CSI is thought to reflect a general consensus of issues that are important to customers.

Within the past two years, UPS has added an additional measure in each of the four areas of the balanced scorecard:

- "Second request customer concerns" in the customer perspective;
- "OSHA recordable injury frequency" in the employee perspective;
- "Quality Report Card" in the internal business process perspective; and
- "Profit Index" in the financial perspective.

The eight measures of the current balanced scorecard are used as an aligning tool for the company's annual business planning process. This process begins at top management levels with development of a multiyear (five- to 10-year timeframe) financial plan that sets a framework for the entire business planning process. The board and management committee use the financial plan as a guide for an annual business plan that sets companywide targets for revenue and profit growth. Top management in each division work with the management committee to translate the companywide plan into business plans for the divisions, operating regions and districts.

The district business plan specifies resource allocation to the different business units within each district. While the balanced scorecard is a factor in allocating resources in the district plan, the allocation is based more on previous allocation, experience and managerial discretion rather than a performance-based budgeting process. However, UPS also uses a reverse allocation process in annual business planning in which the individual business units and operating centers present capital requests to the districts. These requests are then rolled-up to regions and divisions to form companywide capital needs.

This becomes an iterative process with revenue and profit targets balanced against capital needs, resource availability and operating processes.

UPS' organizational structure, with both geographic and functional alignments, was described in the first section. It was mentioned that many corporate functions such as human resources and engineering are replicated at region and district levels. The district business manager, within the district business plan, is responsible for integrating the plans from the different corporate functions into one plan to cover all district functions. The district business plan also details specific actions that will be followed in operating centers and sub-units to achieve targets for each measure. These two features of the district business plan make it the key link in the top-down, bottom up connection of actions (or performance drivers) and measures throughout the organization.

4.0 Major Process Elements

4.1 Evaluation Framework

The overriding philosophy for UPS' performance measurement system is that each management level needs to have unique information all oriented towards a consistent set of strategic goals. For example, UPS feels that certain elements of the business can only be meaningfully measured at more aggregate levels (e.g., profit, return on invested capital), while others are more meaningful on the frontline or for individual centers. UPS states that they have had success in identifying appropriate measures for each decision-making level and understanding connections between measures at different levels. However, they feel that the main challenge is understanding the connection between a lower-level action (sometimes called a performance driver) and newer performance measures at each decision-making level, especially more strategic levels. This connection, as illustrated in Figure 4.1, is similar to the "causal linkage" described by Kaplan and Norton for the balanced scorecard. The main point of Figure 4.1 is the most basic actions at an individual level can be a driver of performance at more strategic levels.

Figure 4.2 presents a framework for UPS' performance measurement system; it indicates the general alignment and linkage of the system between decision-making levels. The general approach, as indicated in the figure, is that top management levels have a small set of relatively strategic measure to assist in their decision-making needs. The number, scope and usage of performance measures broadens at lower levels of the organization.

The UPS performance measurement system begins at the board and management committee level with the *Point of Arrival (POA) metrics*. The POA metrics are a series of measures that top management levels use as indicators that they are on track to achieve the five- to 10-year business plan. As shown in Table 4.1, the POA metrics include lagging, operational and leading indicators. The metrics are derived through a "roll-up" of data collected at lower operational levels to produce more strategic, companywide information. POA metrics are the primary "objective" tool in assisting with decisions on strategic investments and initiatives. In essence, the decisions at the top management level provide the general road map for subsequent action, while the POA metrics provide the type of information needed to produce the general plan and a companywide alignment for other performance measures.

The next level of performance measurement and decision-making occurs in support of the annual business planning process at both corporate and region/district levels. These processes were described in the previous section. The main products of the business planning process are targets for revenue and profit growth as well as resource allocation to district sub-units. Given the products of this level, the primary performance measures evaluated during the process arise from the financial perspective of the balanced scorecard.

Figure 4.1 Linkage of Performance Measures and Performance Drivers

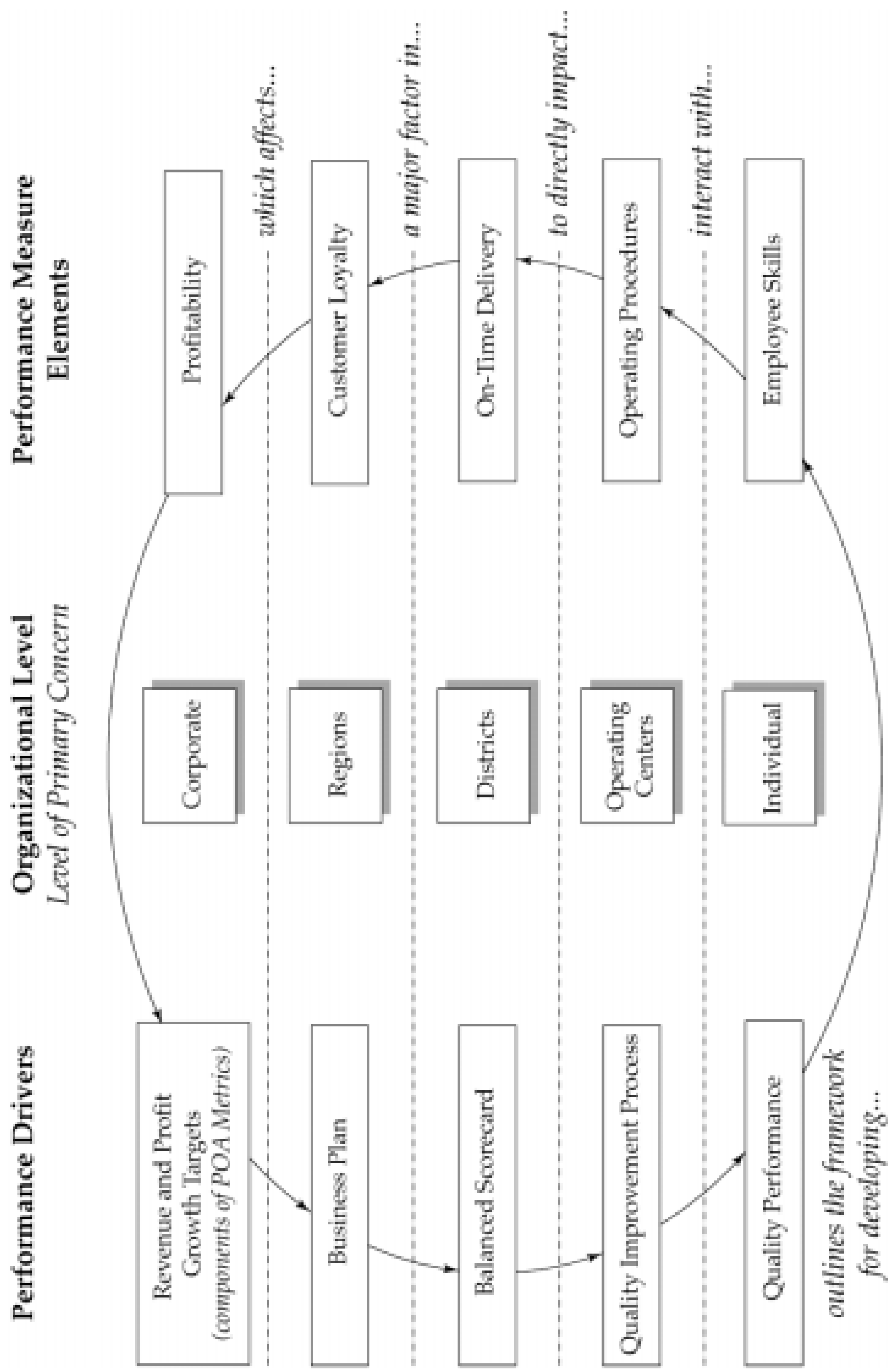


Figure 4.2 Hierarchy for Aligning Goals and Objectives

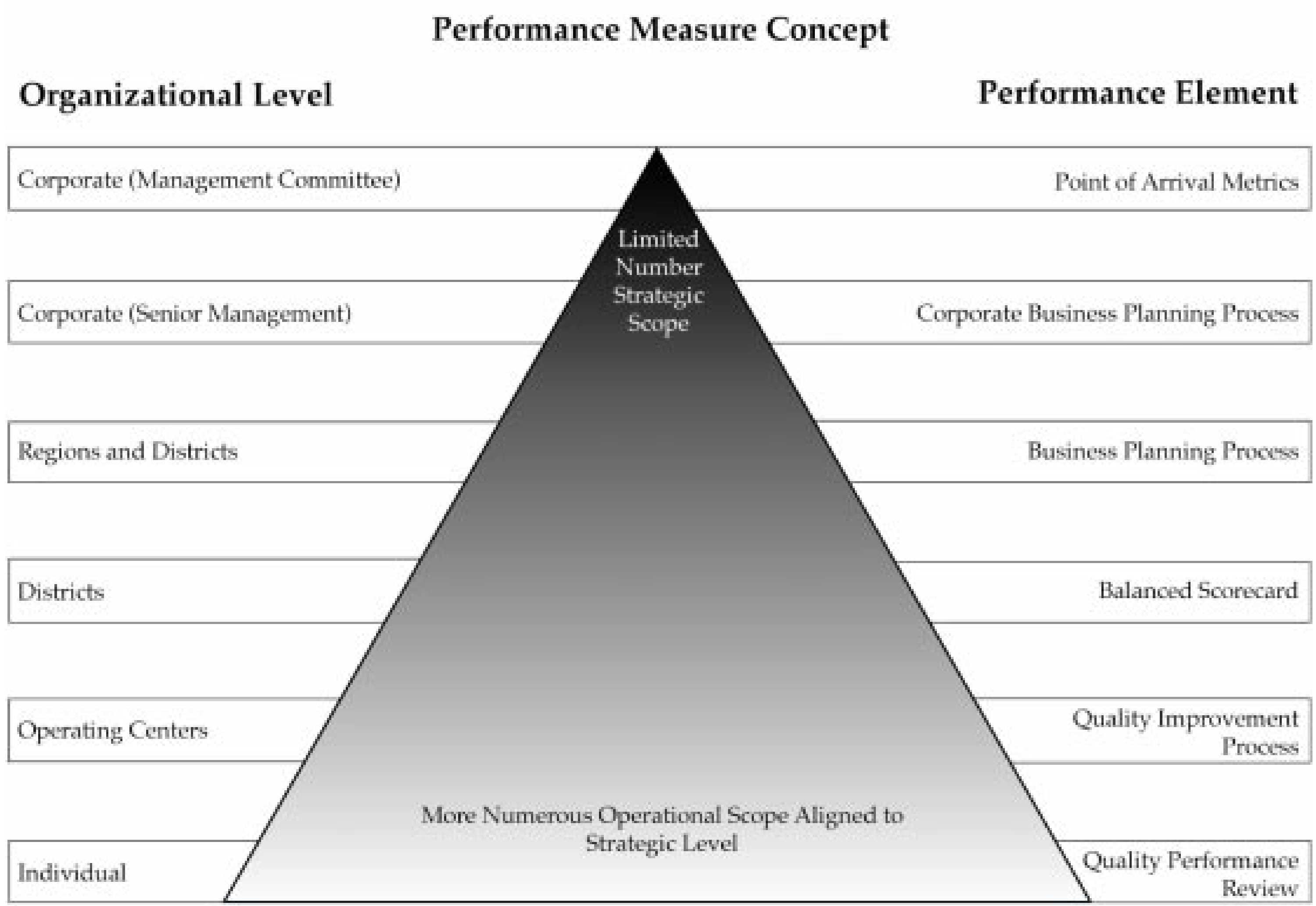


Table 4.1.Point of Arrival Metrics – Corporate-Level Measures and Tracking Interval

Leading Indicators	Operational Indicators	Lagging Indicators
Customer Satisfaction Index (quarterly)	Net Revenue per Paid Hour (monthly)	Return on Invested Capital (quarterly)
Employee Relations Index (semi-annually)	Operating Ratios by Product Type (monthly)	Economic Profit (quarterly)
Time in Transit (weekly)	Operating Expense per Billed Package (monthly)	Net Profit (monthly)
Competitive Position (quarterly)	Revenue per Asset Dollar (monthly)	Stock Price (quarterly)

At the district and operating center level, the entire balanced scorecard comes into full use, with full integration to higher levels. Figure 4.3 illustrates that UPS has identified a number of factors that "define" successful operation of the business at this level. These success factors are reflected in the eight measures currently assessed in the balanced scorecard. Furthermore, the success factors at this level are linked directly to the POA metrics as illustrated in Figure 4.4. This is a clear indication of the attempt that was made to provide alignment within the performance measurement system between corporate and operating levels.

The Quality Improvement Process (QIP) at the operating center level outlines a specific plan for achieving targets established within the balanced scorecard. In essence, the QIP can be thought of as identifying the performance drivers to implement the balanced scorecard. The QIP consists of a short-term "strategic plan" with a subset of goals from the balanced scorecard coupled with a supporting action plan. A feedback process is also included in which districts and center management assesses completion of the action plan and reaching of strategic plan goals on a quarterly basis. Within the QIP, priorities center on measuring performance from a customer perspective, having districts and centers assume the lead for cross functional projects, employee led training, and orientation towards key corporate goals (e.g., claims reduction).

The final stage in UPS' formal performance measurement system is the Quality Performance Review (QPR). The QPR, which connects the QIP to individual staff members, is somewhat similar to the annual review process undertaken in many organizations. However, the QPR is more short term in nature and explicitly linked, through the QIP, to companywide goals and objectives. The QPR includes a shorter-term "action plan" for the employee that provides a guide for day-to-day employment activities. The action plan provides a focus for daily operational plans that arise from review of previous day and trend operating results; the daily operational plan, combined with the action plan, indicate areas of strength and where attention is needed.

Case study participants from UPS view the current performance measurement process as somewhat of a natural evolution from previous systems. In the opinion of these

Figure 4.3 Balanced Scorecard Framework
Division and Operating Center Level

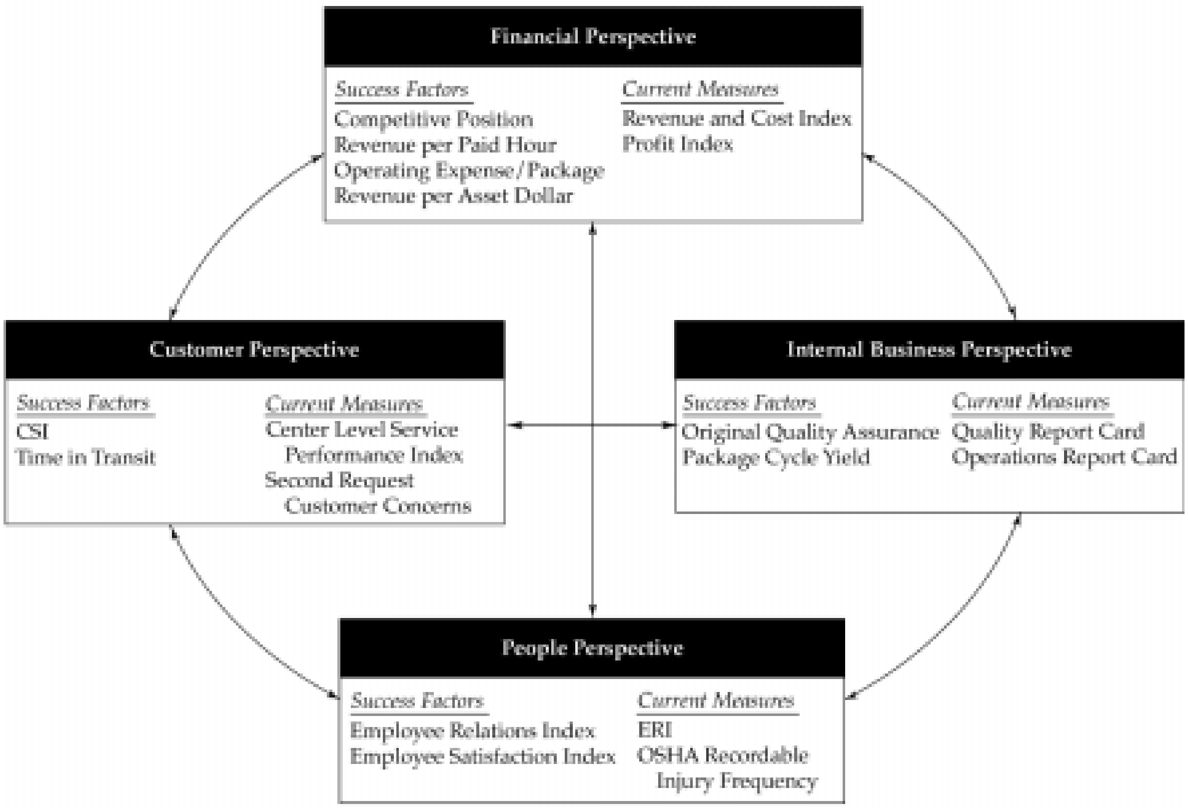
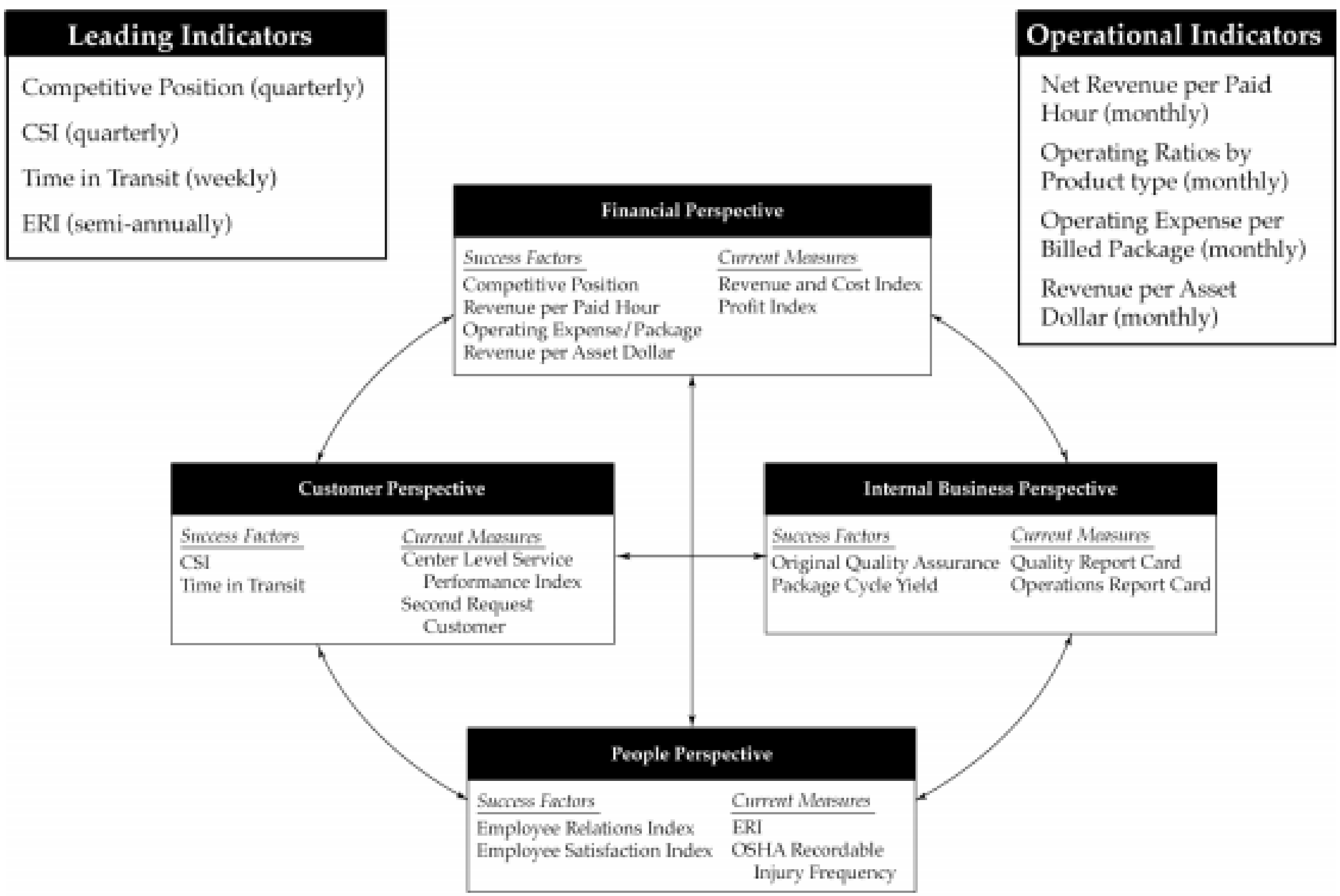


Figure 4.4 Linkage of Performance Measures Between Corporate and Operating Levels
Reflection of POA Metrics in Balanced Scorecard Framework



individuals, UPS has always had some type of internal program to assess costs and efficiency. The current performance measurement framework has enhanced prior ones by incorporating an employee focus into the internal measures, and adding an entire new element focused on external or customer concerns.

As the structure now stands, the internal element can be thought of as addressing cost and efficiency concerns, while the external element addresses volume and revenue as impacted by the customer. Figure 4.5 illustrates that both of these elements are necessary elements in assessing the core business goals, whether those goals and targets are part of the annual business plan or the longer-term POA Metrics. The four components of the balanced scorecard are addressed either within one of the two elements or through the feedback process. Figure 4.5 also illustrates how UPS operationalizes performance measurement through continuing iterations of goal, target, action, measure and feedback.

■ 4.2 Data Collection

For many years, UPS has used ongoing business activities for collecting data in support of performance measurement systems. Packages are electronically scanned at every step of delivery and are tracked throughout their movement between feeders, hubs, individual drivers and the final customer. This tracking information, called *package-level detail*, is available for UPS and customer review almost instantly. Customer call centers are also electronically linked to provide data on customer complaints and service problems. UPS also invests in traditional accounting systems to track revenues and costs from the operations.

These individual elements are connected through sophisticated software to automatically produce reports on various aspects of organizational performance. These reports are produced on a daily basis for frontline managers, and on a weekly or monthly basis for individuals further removed from frontline operations or for more strategically oriented measures. The capability exists to produce thousands of pages of operating reports and statistics every day. Case study participants stated that it is somewhat of a struggle for upper-management levels to “do without” information that may be used regularly at lower levels, particularly given the high level of internal promotion.

Data to support calculation of CSI and ERI are collected through surveys that are not connected to ongoing operations. Separate CSI surveys are performed for the Operations Division and UPS as a whole. These separate surveys, as indicated in Figure 4.6, focus on slightly different factors and result in a Service Performance Index (SPI) for Operations, and a Customer Service Index for the entire company.

Data for calculating the SPI are based on a quarterly mail-out survey to one-fourth of UPS’ ongoing customers; this schedule results in all ongoing customers being surveyed annually. Within this quarterly survey, customers are asked a series of questions about experiences in eight service areas. These questions are very detailed and allow managers to gain a picture of where efforts should be focused. For example, the questions related to tracking are as follows:

Figure 4.5 Interaction of Measurement System Elements to Assess Core Business Goals

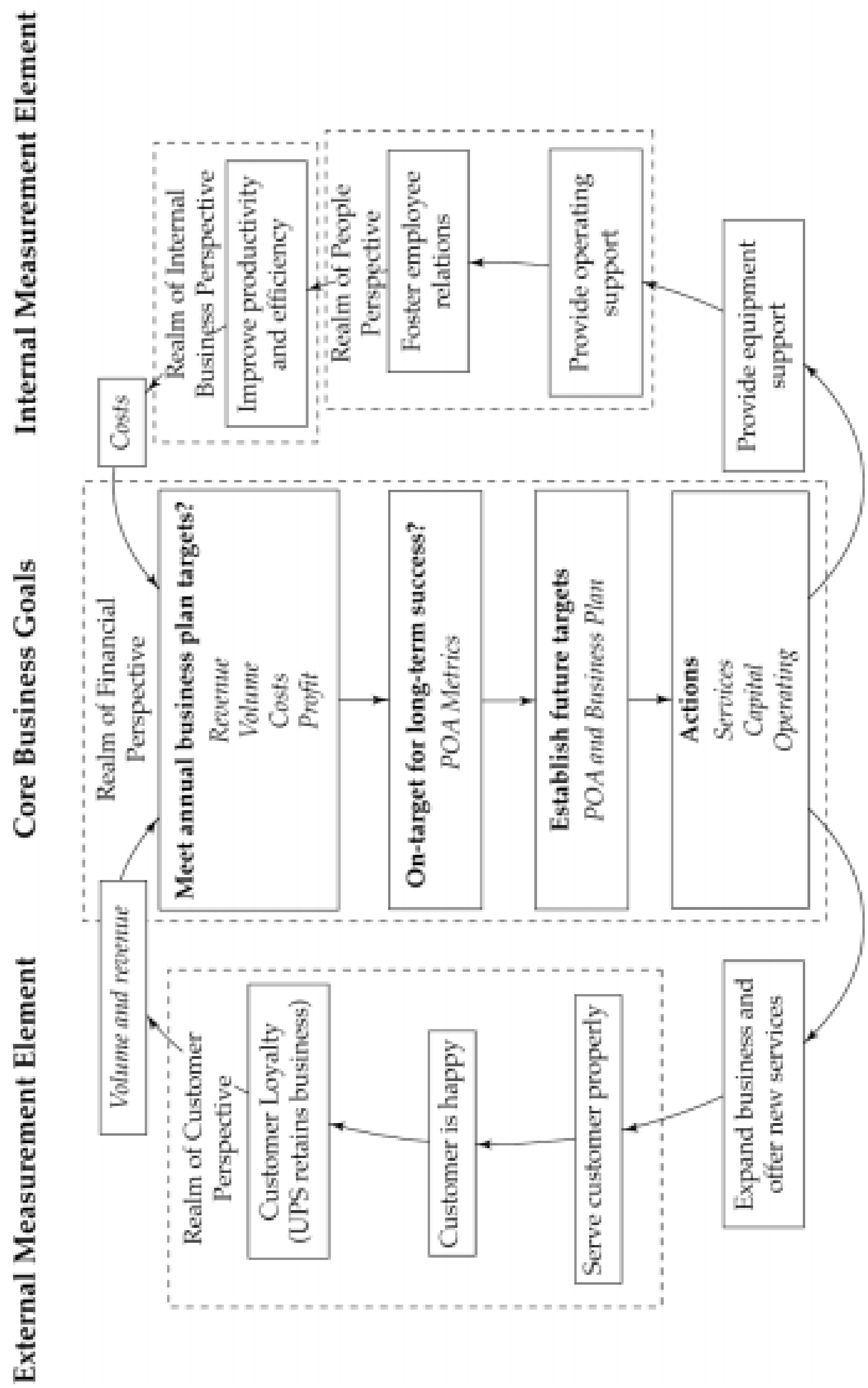
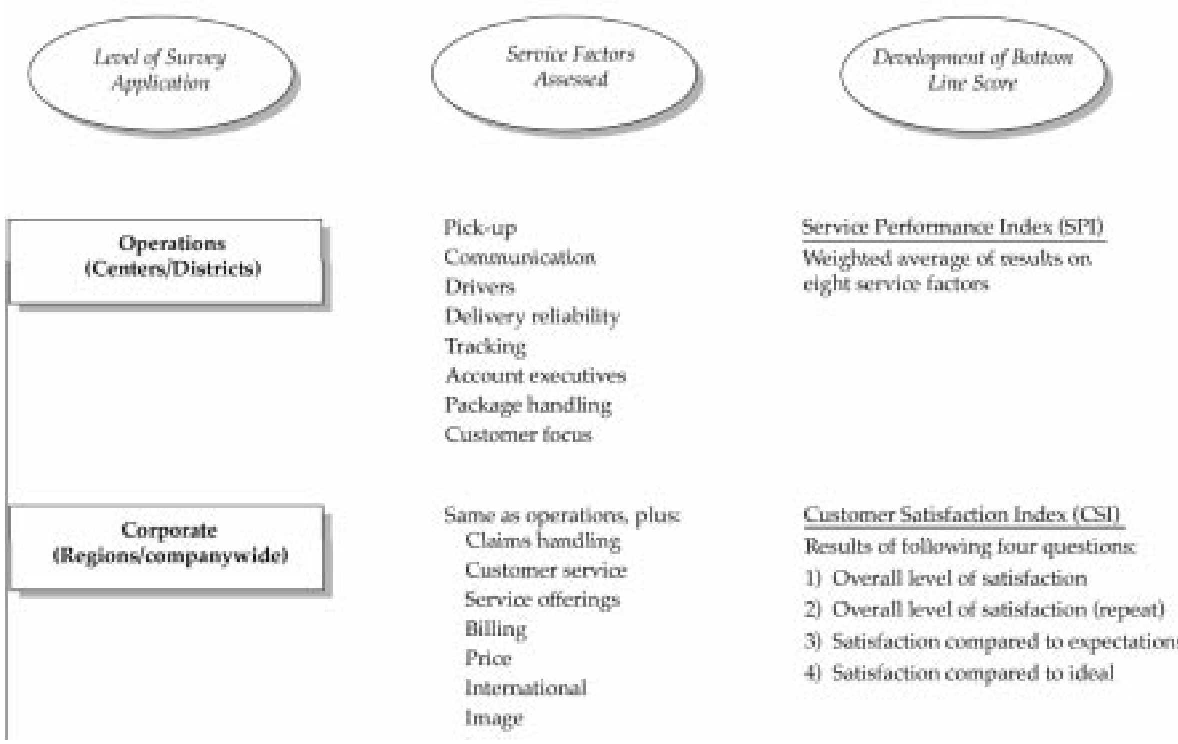


Figure 4.6 UPS Customer Satisfaction Surveys
Service Factors



With respect to ***Tracking****, how would you rate UPS on:*

- *Their ability to tell you where your package is;*
- *Quickly providing the information you requested;*
- *Ease of tracking letters and packages; and*
- *Providing proof of delivery information.*

The SPI is then calculated based on weighted average of answers in all eight areas. The SPI is tabulated initially at the operating center level with these scores then rolled up to the district level.

The corporate CSI is based on data collected in 300 phone surveys conducted per quarter in each geographic region. CSI scores are tabulated initially in operating regions and then rolled up to the companywide level. The corporate CSI survey asks questions in 15 areas, and then develops a CSI based on responses to four additional questions not directly related to specific service issues. In developing the SPI and CSI, UPS weights responses based upon the volume and revenue "value"; this process allows the company to reflect the reality that certain customers can have a larger impact on achieving certain performance measures in the finance and internal business process areas.

Tabulation of the ERI is based on a semi-annual survey of all employees. The ERI survey contains 17 questions to ascertain rank-and-file opinions of employee/management relationship within both confined geographic areas and companywide. The ERI is tabulated initially at the operating center level and then rolled up to corporate level.

UPS expends a considerable amount of money to support their data collection activities. In 1996, the company spent over $1 billion on information technology (IT). This expenditure helps maintain and update the 13 mainframes, 165,000 personal computers, and 80,000 hand held computers used to support information collection and dissemination at UPS. However, it should be reiterated that IT expenditures at UPS are undertaken to support ongoing operations and provide timely information to customers; evaluation of performance measures are a secondary benefit of these expenditures. The CSI and ERI surveys represent the only data collection performed solely for performance measurement purposes; case study participants estimated that the company spends much less than one percent of the IT expenditure on the collection and tabulation of these surveys.

Information collection and use has always been an important activity at UPS, and is undertaken in nearly all corporate divisions. However, one division is responsible for developing the approach and computer systems to support these activities. Current system development activities are focusing on the real-time integration of computer systems between operations and customer support divisions. The current lack of companywide systems integration was pointed out by several case study participants as the biggest weakness in the UPS performance measurement approach.

5.0 Process Impacts

In spite of recent labor disruptions, UPS is achieving its greatest financial success now with more districts and regions meeting their business plan targets. However, these results do reflect greater attention to the most profitable business segments and customers. Furthermore, external and internal reviews have shown that company can (and must) do things it would never have allowed in past such as giving discounts to key customers to get and maintain business. Some individuals view these results as somewhat of an anomaly considering productivity and cost-efficiency have consciously slipped in favor of customer attention. However, other individuals expressed an opinion that recent financial success is due in part to a top-down directive to focus more heavily on profit rather than other aspects of the balanced scorecard.

The current performance measurement system at UPS has evolved over many years, and it is now considered somewhat of a "mature" system. When combined with internal promotion of management, most decision-makers at the company have a certain comfort level and familiarity with performance measurement and with UPS' systems. Given this experience and system "maturity," there tends not to be much trouble with misinterpreting "noise" in the performance measures.

While there are clearly defined elements to the performance measurement system at each level, the link between a decision and changes to performance measures is not clearly understood at all levels. Problems that were once addressed relatively easily through experience and intuition have become somewhat muddied. For example, management and staff in frontline levels understand how to impact traditional productivity measures such as claims or on-time delivery. With the need to now tie-in customer measures, there is not a clear understanding of how actions that affect productivity measures will impact customer-oriented measures. In other words, they need to understand how objective measures of operations correlate to a customer's views of those measures. The value of system would be greatly enhanced if they could understand how a change in an internal measure such as productivity correlated with a change in an external measure CSI. Case study participants were not even sure that it is possible to develop such a clean connection.

For example, there could be a need to reduce capital purchase requirements to align the district business plan with corporate targets. Such a reduction could mean that productivity metrics need to improve such as through having each driver make more stops each day (greater volume per driver). However, such an action (or performance driver) may have negative impacts to the ERI metric due to longer work hours; a reduction in ERI could then spill-over to other measures such as CSI and on-time delivery. While the balanced scorecard allows a broader look at issues, the relationship and tradeoff between different measures is not clear. The big work now is determining what is an appropriate tradeoff as well as how to assist the frontline in considering both immediate decision-making needs and potential downstream consequences to strategic measures.

As suggested previously, a feeling was expressed by some individuals that productivity and efficiency are still the principle concerns of upper management. Through the years, UPS developed, tested and implemented a wide range of operational standards to guide literally every aspect of package delivery and work performance. These operational standards, called the Master Standards Data, are still periodically tested and updated, and remain required elements of training and work performance. The individuals suggested that a lack of similar standards for other elements of the balanced scorecard result in less attention being paid to those other elements.

With the large amount of data generated for their performance measurement systems, a big question remains as to who "owns the data." Figure 1.1 illustrated the different divisions that have a role in data collection. For example, Engineering develops specifications for the computer systems, Information Systems translates the specifications into the actual systems, Operations and Marketing collect the data, and Engineering and Business Development process the raw data and produce reports. With so many divisions involved, there is no clear ownership of the information. This lack of clarity has, at times, created conflicts in the organization since the information is quite robust. Case study participants suggested that, within any organization, such robust information could be a powerful tool for whichever management group controls it.

6.0 Experience and Lessons

Case study participants stated that a performance measurement should be **applied** in both top-bottom and bottom-up fashions. However, the system should be **established** solely top-down, with key corporate goals, rather than data availability, used as the driver and alignment mechanism for all measures. The participants stated that a consistent alignment approach is needed to assist lower levels in understanding the impact of performance drivers and interaction between measures.

With the wealth of data and information available to management, there is a constant need at UPS to identify the most important decision-making needs at each level and focus on that information. Since most upper management at UPS started at lower levels and were promoted from within, they tended to develop an affinity for information availability at lower levels. Many individuals struggle with a temptation to gather and review detailed information since it is readily available. Participants stated that in many instances they have to force themselves not to look at information on a daily basis.

For more senior decision-making levels, it was felt that monthly or quarterly reviews of measures versus business plan targets is appropriate. While a focused look at one or two measures may be appropriate at lower- and middle-management levels, upper levels cannot expect a few "key measures" to provide a complete picture of system performance. It is necessary to consider all measures simultaneously since no clear connection has yet been established between the measures. At UPS, the emphasis remains on providing the least amount of information that is needed to made an informed decision. In order to do this, UPS constantly readjusts the type of information it provides; case study participants felt that an iterative trial and error process is appropriate for this activity. The timeliness of information is more critical than quantity of information at all levels, particularly in terms of feedback when there is a need to isolate the effect of new initiatives.

In spite of its perceived success, a feeling was expressed that formal performance measurement systems are not appropriate for assessing everything. Some activities like the UPS Foundation, Olympics sponsorship, and community relations defy strict effectiveness measures.

Performance measures do not provide a complete enough picture for all possible situations. For example, multiyear capital investment plans are prepared at all levels of the organization. In developing these long-range capital plans, UPS managers consider the balanced scorecard and POA Metrics. However, other factors such as prevailing economic conditions and asset availability, condition and usage are, by necessity, also important considerations. This information needed to develop the capital plans is quite different from that needed to make operations-oriented decisions. A few individuals expressed an opinion that UPS' balanced scorecard method is better suited for operational rather than long-range capital decisions. They felt it would be very difficult to develop one system to address all possible scenarios. Intangibles always exist and there will never be a substitute for instinct.

Given the concerns UPS has experienced with data ownership, the transportation planning field may want to begin exploring the issue. With the potential to automatically collect data using ITS, instrumented vehicles or advanced surveying techniques, planning information may become readily available from many different sources. Groups other than planners and traffic engineers could begin to be sources of valuable information for transportation planning.

UPS' IT budget was mentioned in a previous section. The company has invested heavily in information systems over the last five to 10 years. In many cases, they tended to underestimate system maintenance and upgrade costs. Furthermore, they also did not anticipate additional costs that are incurred just by virtue of having data available (e.g., customers now wanting information over the internet). An aggressive investment in IT and data collection undoubtedly creates a need for even more investment, with a potential for unforeseen costs of previous investments taking resources away from investments in new systems.

7.0 Future Plans

UPS is committed to the performance measurement and the balanced scorecard approach. To instill these systems throughout the company, top management is coordinating reward and recognition system with the balanced scorecard. For example, the top award at UPS is the Chairman's Award; the scoring system for this award has been modified to reflect a 25 percent weighting of the four major elements of the Basic Scorecard. However, many staff still struggle with integration and use of CSI and ERI at lower operational levels. Many staff members perceive it as relatively easy to influence an operational or financial performance measure; linking these types of actions to fuzzy issues is more troublesome.

The management committee has recently established Process Steering Committees to determine actions that are needed to align business functions with strategic directives and the balanced scorecard approach rather than specific activities and functions. The work initially identified seven core processes that were then reduced to four (package management, product management, customer information management and customer relations management) and directly linked to POA metrics. This process has underlying performance considerations of CSI, shareholder value and improved efficiency; each consideration has at least one coordinating POA metric. Hence, the process illustrates how the companywide POA metrics are being further used as the performance measures for evaluating the success of the four core processes.

Case study participants stated that the company would like to better understand how to influence CSI scores through different types of performance drivers. UPS sees CSI as the customer's perception of productivity and operational measures. It would be helpful (and very powerful) in the long-term to use productivity and operational measures to predict CSI, and vice versa. This would essentially link leading and lagging measures. To assist in this endeavor, UPS has been using focus groups to capture customer "needs" in their own words. They are aiming to develop some type of "customer needs statements" to refine the structure of the CSI over time.

UPS developed the balanced scorecard with CSI and ERI in hopes of providing a clearer link between operating and strategic levels. As part of this link, they expected to see some type of measurable interaction between CSI and ERI. Neither one of these interactions has occurred yet in a measurable fashion. UPS is considering transitioning the Employee *Relations* Index into an Employee *Satisfaction* Index as a way to test if an interaction can be developed with CSI.

8.0 Contacts and Source Material

Further information on UPS and their measurement systems can be obtained through:

United Parcel Service
Public Relations Department
55 Glenlake Parkway, NE
Atlanta, Georgia 30328
(404) 828-7123

Appendix B

Phase I Final Report

1.0 Introduction

1.1 Purpose of the Study

NCHRP Research Project 8-32(2), Multimodal Transportation – Development of a Performance-Based Planning Process, is intended to support a new era of transportation planning efforts at the federal, state, and regional levels. The impetus for these planning efforts is a series of factors that have not only increased awareness of a more broad range of goals and objectives for transportation, but have helped identify the diverse set of customers that the system must serve. These factors include:

- The ISTEA legislation with its emphasis on multimodal solutions and its long-range planning, financial planning, management system, and flexible funding provisions;
- Heightened concern about the most effective use of scarce resources in an era where traditional transportation funding sources are not generating sufficient revenue to meet perceived needs, yet the public continues to be in a “tax revolt” mood;
- Increased awareness and concern about the role of transportation in supporting economic competitiveness, as changes in the national and global economies place new demands on the transportation system, especially for freight and goods movement, and international trade agreements open new markets;
- Environmental laws and regulations and particularly the Clean Air Act and Energy Efficiency Act;
- Social and equity concerns reflected in legislation such as the Americans with Disabilities Act;
- Growth management, congestion management, and transportation/land use laws and regulations; and
- A variety of new technologies offering a wider range of transportation solutions including Intelligent Transportation Systems (ITS), alternative fuel vehicles, high-speed rail, etc.

This report documents the Phase 1 research which includes an inventory of the most recent research and applications in performance-based planning, development of a conceptual framework, and identification of methodological improvements to support application of performance measures to the planning process. A series of three regional “advisory group” meetings were conducted in Phase 1, and some of the more important findings from these meetings are incorporated into this report as well.

1.2 The 8-32 Research Projects

NCHRP 8-32(2) is one of five projects which review emerging issues affecting planning and program decisions, assess current and new institutional and technical approaches, determine the steps required to address emerging issues, and develop a research action agenda. A 1993 workshop set a detailed research agenda, including five specific projects, of which 8-32(2) is one. The other four research projects in this series are:

- **8-32(1)** – Innovative Practices for Multimodal Transportation Planning for Freight and Passengers: The objective of this project is to identify examples of promising and innovating multimodal planning practices currently used for both freight and passenger transportation.

- **8-32(3)** – Integration of Land-Use Planning with Multimodal Transportation Planning: This project will provide planners and decision-makers with analytical tools that describe and measure the interrelationships between transportation facilities and services and land use on a regional and project-level basis.

- **8-32(4)** – Developing and Maintaining Partnerships for Multimodal Transportation Planning: This research will identify examples of successful partnerships in a variety of situations, and thereby develop strategies and tools for establishing such partnerships in freight and passenger transportation planning.

- **8-32(5)** – Multimodal Transportation Planning Data: The overall objective of this research is to develop guidelines on the availability and use of data to support statewide and metropolitan multimodal planning that meets ISTEA and subsequent regulations.

1.3 The Work Program and Approach

The 8-32(2) Phase 1 work program follows closely the original research statement developed by NCHRP. That statement called for development of a framework and approach to transportation planning that integrates a broad set of objectives into a planning process focused on performance and outcome. The performance evaluation framework is to be applicable to a variety of surface transportation modes, to urban and rural settings, state and local contexts, freight and passenger movement.

The approach to this research statement incorporated five distinct tasks:

1. Assembly of a thorough inventory of the basic elements which comprise the performance-based process, including example goals, objectives, and performance measures, and the decision-making and planning approaches driven by the measures. Examples were drawn from the public and private sectors, from transportation and non-transportation fields. Sources included published plans, other research reports, interviews with practitioners, and focused case studies of current planning processes.

2. The case studies merit special mention, as they were an important source of information for this study. A broad range of transportation situations was included in the case studies, from statewide multimodal transportation planning efforts, to regional and facility-level implementation projects. We included multi-state undertakings as well as public-private partnerships and turnkey projects. Findings from these case studies are sprinkled throughout this Phase 1 report, and in some cases have been highlighted in text "boxes" within the report.

3. Development of a typology of goals and objectives, establishing relationships between the goals, objectives, and measurements of transportation system performance. The purpose of the typology in Phase 1 is to clarify how the selection of appropriate performance measures is a function of the particular goals and objectives, and further, how the data needs are in turn driven by the goals, objectives, and measures. The linkages between these elements of the process, and the feedback loops integrated into the process, are important defining features of a performance-based planning process.

4. Identification of analytical methods which could be necessary to operationalize a new generation of performance measures. These methods include data collection, storage, manipulation, and analysis procedures. A broad range of possible techniques, and potentially desirable methodological enhancements, are identified in order to accommodate a wide range of agency resources and needs.

5. Convening several advisory meetings to uncover examples of experience with performance-based planning techniques and to solicit feedback on the research to date. During 1995, three advisory meetings were conducted in Cincinnati, Portland (OR), and Atlanta. These meetings had a regional focus, involving participants from state DOTs, MPOs, transit authorities, and private owners/operators. The final advisory meeting was held in Washington DC, in April 1996, and include numerous participants from agencies and organizations with a national perspective, as well as additional local, regional and state agency participants.

Each of the first three tasks above culminated in a technical memorandum describing the research findings and conclusions. The three regional advisory meetings were documented in a separate memorandum. The findings of all five of these tasks have been integrated into this Phase 1 Final Report. The three technical memoranda, documentation of the 10 case studies, and a summary of the proceedings of the three regional advisory committee meetings were previously delivered to NCHRP and the Project Panel as an this Phase 1 Report when published in August 1996.

2.0 Experience to Date

This section provides a summary of the findings of our exploration into applications of performance-based planning methods within and outside of the field of transportation. The more complete documentation of this work will be found in Technical Memorandum No. 1, provided as an appendix to this report.

2.1 Overview and Summary

The research documented in this section focuses on examples drawn from a wide range of sources. In keeping with the research statement for this project, there has been a special effort to investigate the use of performance measures in non-transportation fields and in non-governmental sectors to determine whether there are concepts or lessons which are of value in developing a framework for performance-based planning in the public transportation field.

This information comes from a review of recent studies from a variety of disciplines, as well as new interviews conducted by the research team. We have conducted a thorough review of public agency transportation planning efforts as documented in management system plans, regional transportation plans, and statewide plans. We have searched for examples of application of performance-based planning and management in the private sector freight transportation industry. Outside of the transportation arena, we have looked into private sector applications, such as the power generation industry and the services industry, as well as public sector applications including social services, education, and more.

Overall, this research has identified numerous worthwhile findings which offer guidance in the development and eventual implementation of a performance-based multimodal transportation planning methodology, as summarized in the following points:

- It is important to develop a methodological structure that can manage a potentially overwhelming number of alternative approaches and specific performance measures. To this end, it is useful to define broadly-acceptable categories and criteria to help select and organize performance measures in a way that improves their clarity and meaning. This structure and its various definitions and conventions then needs to be communicated to a broad audience to facilitate refinement and implementation of the concepts.

- A working definition of the terms that make up a performance-based planning framework is helpful, as evidenced by the wide variability found in recent applications. Suggesting common definitions of the terms "policies," "goals," "objectives," "standards," "strategies," "recommendations," etc., as simple as it sounds, will be very useful in developing broader understanding and application of the concepts. We provide suggested criteria for defining goal and objective statements we believe will result in more "operational," quantifiable statements.

- The concept of composite performance indexes which distill a variety of dimensions into a single measure is of interest to decision-makers, due to the potential complexity and volume of performance-related data. Experience gained in the regional advisory meetings, however, suggests that composite measures may mask important differences or nuances in the underlying data, and may be too coarse for evaluation of local and regional investment alternatives. Our proposed framework addresses this issue by accommodating both broad performance measures to guide long-range planning, and more specific evaluation criteria to be applied to more specific short-range planning tasks or implementation decisions.

- To date, the actual impact of performance measurement on the decision-making process has been somewhat limited. There are notable exceptions, but the evidence suggests that incremental application over time will be required to significantly alter the historical processes by which transportation investment decisions are made. As noted by participants at the Portland, Oregon regional advisory meeting, translation of the analytical process to policy formation and decision-making has been slow.

From the electric power generation industry come the concepts of *integrated resource planning (IRP),* or *least cost planning (LCP),* with potential application to transportation. These methods have taken a number of years to catch on in the utility industry, and it is likely that current efforts to apply IRP or LCP techniques to transportation will also require a significant amount of adaptation and time to infiltrate to any degree. Reasons for this include:

- Relative to the power generation industry, the greater degree of consumer choice in transportation leads to a significantly more complex mix of possible outputs, making it more difficult to actually measure productivity and to compare relative efficiency of competing alternatives. LCP techniques would require substantial enhancement to be transferable to the greatly varied world of transportation.

- As transportation planners, we have less complete knowledge about consumer response to both demand and capacity management strategies than do our counterparts in the utility industry. It is thus more difficult to isolate those measures which will best capture the effectiveness of alternative strategies, as well as more difficult to predict in advance the outcome of investment strategies which require long lead times.

- Relative to the utility industry, the public transportation sector has less information on total costs and benefits, and fewer and/or less sophisticated analytical tools. Ongoing efforts to identify the total costs and benefits of transportation, and to improve analytic capabilities to conduct the necessary evaluation of alternative strategies, will be of benefit in implementing performance-based methods in transportation.

A great deal of relevant information comes from the private service industries, where significant effort has been devoted to understanding the importance of the customer in defining and measuring performance:

- The relationship between customer satisfaction, productivity, and profitability is better appreciated in the service industry. Efficiency alone will not lead to sustained productivity or profitability; a high level of customer service and satisfaction is needed.

- Customer-oriented performance measures and standards are becoming the norm in service industries. This can be attributed in part to the increased competition for consumers' attention and business necessitated by the information technology boom. As customers have more immediate and complete access to knowledge about competitors' products and services, their perception of service and value will have an ever greater impact on choice among competing alternatives.

- Measurement of performance in the service sector bears certain similarities to that in the transportation sector. Important attributes of the products of the service industry include:

  – Services are often intangible, e.g., they are performances rather than products, for example maintaining ice-free pavement;

  – They are heterogeneous, that is, there is a wide range of variability in the acceptable standard of performance, making it difficult to compare across regions or customer bases;

  – They may be spontaneous in production and consumption, for example, a hair cut or a bus ride. This can actually be turned into a benefit, because it simplifies the collection of customer satisfaction data; and

  – They are generally more perishable than non-service outputs, in that once a service is provide, it has no "shelf life" and the customer has a short memory. The next bus trip must be just as good as the last to retain a positive customer perception.

These factors should be taken into consideration in determining *how* performance is measured in the transportation field, to the extent that a more service-oriented, customer-based approach is desirable.

Additional considerations gleaned from public sector, non-transportation fields include:

- Making goals *operational* versus *non-operational* is important in quantifying performance. A goal which can be unambiguously compared to an existing situation is operational. As an example, "reform criminals" is a non-operational goal; "double the rate of inmate participation in prison programs" is operational and can be *linked* to specific measures and effectively *tracked* with those measures.

- Measuring *outcome* rather than *output* is also a concept with value to transportation. While output is related to efficiency, outcome measures are a better indication of effectiveness. For example, "average length of hospital stay" is an output measure for the health care industry; "readmission rate" or "mortality" rate is a measure of outcome and effectiveness of the service. A transportation analogy might be "number of ice-related accidents" rather than "tons of salt applied." The former measures the outcome or impact of an effort or investment, the latter measures only the output of the crew.

- In comparative evaluation of organizations which compete for available funds, it is particularly important to isolate and account for external factors which impact outcome but not input. The same is true of transportation programs; the system of performance measures needs to be concise enough to minimize the likelihood that external factors not picked up by the methodology are in fact responsible for the noted changes in performance measures.

These lessons are described in more detail in the following sections.

2.2 Experiences in Transportation

The basis for any successful planning effort is a clear, concise, and achievable set of goals and objectives. This is neither new nor unique to performance-based planning. Unfortunately, the past practice has often been to de-emphasize or ignore broad-based goals and objectives shortly after plan development, as the focus progresses to evaluation and implementation of specific transportation projects. This is a relatively widespread shortcoming of the current practice which performance-based planning can help address.

Certainly there has been a movement towards integration of performance criteria and project evaluation. ISTEA regulations have stipulated that there be consistency within all elements of the transportation plan, as well as between the plan and the projects which are eventually implemented. This explicit linkage has prompted most agencies to give more careful thought to the types of issues raised in the goals and objectives. There is now a greater tendency to integrate multimodal performance criteria in project evaluation to assess the achievement of the overall goals. However, our research and discussions with practitioners around the country strongly suggests that the linkages and feedback loops which are critical components of a successful performance-based process are not yet fully implemented in most cases.

2.2.1 Goals and Objectives

The composition of goals and objectives, as well as the terminology ("policies," "goals," "objectives," "strategies," "recommendations") used to describe them vary widely in the transportation planning documents reviewed. Typically, however, the planning documents contain a series of very broad and general goals related to one or more policy areas, followed by a number of more specific goals or objectives. The following excerpts from recent statewide transportation plans illustrate this point:

- **"Manage, maintain, and expand system capacity**
  - Expand system capacity to relieve congestion and to facilitate interregional travel and commerce; and
  - Make cost-effective transportation investment decisions through the use of transportation management information systems.[1]

[1] California Transportation Plan.

- **Goal #4: Transportation Safety and Convenience**
  - Policy Statement B – Reduce injuries and property damage at Ohio's rail-highway grade crossings; and
  - Initiative: Upgrade Ohio's 3,700 existing passively protected rail-highway grade crossings."[2]

With reference to the previous comments about "operational" goals, one can see that some of these goals can be unambiguously evaluated and compared more readily than others. The following definitions are proposed to facilitate generation of operational goal and objective statements, and to promote understanding of the important nuances between performance-based planning and more traditional planning processes:

- **A goal is a general statement of a desired state or ideal function of a transportation system. For example,**
  - "Promote economic development."[3]
  - "Protect the public's investment in transportation."[4]
- **An objective is a concrete step towards achieving a goal, stated in measurable terms, e.g.:**
  - "Reduce the number of commercial vehicles that exceed legal weight limits on the State Highway System."[5]
  - "Reduce the number of at-grade railroad crossings."[6]
- **Objectives may have specific performance standards which set out in clear, numerical terms a desired or required degree of achievement:**
  - "Provide transit service in all urban areas/corridors with more than xxx population."
  - "Travel times in urban areas/corridors should not deteriorate below 1994 levels."[7]

We found that relatively few of the planning documents we reviewed included specific, quantifiable performance *standards* which related to objectives. Thus, for example, there were many objectives found which called for "improving" or "reducing" a particular

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[2] Ohio Statewide Transportation Plan, Access Ohio (October 1993).

[3] Transportation Choices 2020; Part One, The Policy Framework (New Jersey DOT, December 1994).

[4] 2020 Florida Transportation Plan.

[5] Ibid.

[6] Mississippi draft final Statewide Transportation Plan (November 1994).

[7] Sample policy paper from the Texas Transportation Plan Issue Committee Notebook (Dye Management Group, 1994).

condition or occurrence, but it was less common to find *relative* numeric targets, e.g., "improve by 30 percent..." and even more unusual to see *absolute* targets such as, "reduce to XX the number of...". The relative absence of such numeric performance standards may be due to agencies' understandable reluctance to establish such a specific target without first gaining some experience with these new objectives and measures. While we have had Level of Service and other common measures around long enough to know what constitutes a "good" or "acceptable" standard of performance, this is less the case with many other quantitative measures such as delay, travel time, accessibility indices, etc. (See box below.)

Oregon Benchmarks as Performance Standards

The topic of performance standards was debated at length during the Portland, Oregon regional advisory meeting in November 1995. The Oregon Benchmarks define specific standards or thresholds of performance to be attained on a great variety of public policy matters, not confined to transportation. The Benchmarks affecting transportation include standards such as, 'increase to 60 percent by the year 2010 the percentage of Oregonians who commute to and from work during peak hours by means other than a single occupant vehicle, or, increase to 88 percent the percentage of Oregonians who commute 30 minutes or less (one-way). Proponents of standards contend that a clearly-defined target, even if it proves to be unrealistic, is necessary to initiate meaningful action on the part of planners and decision-makers alike. Opponents counter that pursuit of standards tends to distort the planning process, diverting attention away from underlying objectives. Decisions become optimized to achieve certain targets, and "the solution becomes the goal."

To avoid a situation in which the broader goals and objectives are lost in the pursuit of numerical targets, participants agreed that if standards are to be set, they should be flexible, rather than set in law, and should be incremental, so that periodic "successes" can be observed and revisions made to the process as necessary. A range of goals, rather than a single overriding goal, should be addressed by the standards, to reduce the likelihood of getting stuck on a single, possibly unattainable, goal.

Source: Regional Advisory Meeting, Portland, OR, November 1995

2.2.2 Issues that Drive Goals and Objectives

In preparing their transportation plans, state DOTs, MPOs, and other planning agencies address a wide range of issues. In identifying these issues, the agency defines, in effect, the role of their transportation system. For instance, by identifying "quality of life" as an issue for consideration in their Statewide Plan, the state of Missouri has established that the transportation system has a role in maintaining and enhancing quality of life, whether by easing congestion, providing disaster relief, or otherwise affecting the human environment. This notion of the *role* of the transportation system is continued in our later discussion of the performance-based planing framework, where we note the importance of defining goals and objectives that can be demonstrated to relate to the basic roles of the transportation system in society.

A recent survey of state transportation plans was performed in conjunction with the National Transportation System Framework/U.S. DOT Restructuring Process. This survey included a review of 20 statewide intermodal transportation plans and management system work plans. This research was used to help identify the wide variety of issues addressed in these plans, and was supplemented by a review of management system work plans at the MPO level and of other county and local plans.

Table 2.1 presents 37 issues identified in the review of statewide planning efforts. The statewide plans were found to be the most comprehensive in terms of the breadth of goal and objective statements, as compared to the MPO, county, and local plans. Of the 20 states surveyed, as few as four and as many as 31 goal statements were identified in the plans. In some cases, however, a single goal statement has been defined so as to encompass a number of topics. For instance, one of Florida's goal statements encompasses mobility, environment, community values, and energy conservation.

The examples in Table 2.1 show that virtually all states surveyed addressed safety, economic development, the environment, system preservation, and intermodal efficiency. The influence of the ISTEA legislation is quite clear in this sample. On the other hand, relatively few states addressed issues such as improving the state DOT work force, rural development, and improved construction techniques. The sheer range of goals suggests that any framework for performance-based planning needs to be flexible rather than proscriptive in order to accommodate the different needs of different users.

2.2.3 Categories of Goals and Objectives

The breadth and depth of issues identified by transportation planning agencies produce challenges for decision-makers. Even if adequate information is provided for each issue identified, tradeoff decisions become increasingly complex as the volume of information multiplies. It is useful, therefore, to group the issues into broader categories, for which appropriate goal and objective statements can then be formulated. This will in turn keep manageable the number of performance measures adopted, and ensure that the measures and goals can be traced back to an identified issue raised during plan development.

The following nine categories of goals and objectives arise from the review, and are suggested for use in further development within the framework:

1. Economic Development;
2. Environment;
3. Safety;
4. Efficiency;
5. System Preservation;
6. Mobility;
7. Equity;
8. Stable Funding; and
9. Customer Service.

Table 2.1 Issues Cited in Statewide Transportation Plans

STATE	AL	CA	FL	ID	IL	IA	MD	MN	MS	MO	MT	NJ	OH	OR	SC	VT	WA	WV	WI
Economic Development	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cost Reduction	✓	✓				✓		✓		✓		✓	✓	✓			✓		✓
Environment	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	✓	✓	✓	✓	✓		✓
Safety	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓		✓	✓	
Freight/Pax. Coordination	✓					✓	✓	✓	✓			✓	✓		✓		✓		✓
Mobility Disadvantaged	✓	✓	✓							✓	✓		✓	✓					
Intermodal Efficiency	✓	✓		✓	✓			✓	✓		✓	✓	✓	✓	✓		✓	✓	
Energy	✓	✓	✓	✓	✓	✓			✓			✓	✓	✓	✓		✓		
Public Involvement	✓	✓		✓		✓		✓		✓		✓	✓	✓	✓		✓		
Efficiency	✓	✓		✓		✓	✓	✓			✓	✓	✓	✓	✓	✓			✓
Rural Development	✓	✓									✓			✓					
System Presentation		✓	✓	✓	✓			✓	✓	✓	✓		✓	✓		✓	✓	✓	✓
Mobility		✓	✓		✓	✓	✓		✓	✓		✓	✓	✓					✓
Community Values		✓	✓		✓	✓		✓				✓		✓			✓		
Non-Highway Modes	✓	✓	✓	✓	✓		✓	✓			✓	✓		✓	✓			✓	✓
Congestion	✓	✓	✓	✓			✓			✓	✓	✓		✓			✓	✓	✓
New Technology		✓		✓	✓	✓		✓		✓	✓	✓		✓	✓				✓
Improve Planning Process		✓		✓	✓	✓				✓	✓	✓	✓	✓	✓				
Public/Private Partnerships	✓	✓		✓	✓	✓				✓	✓	✓	✓	✓	✓		✓		✓
Stable Funding		✓		✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓		
Multimodal Alternatives		✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓	✓		✓	✓	✓
Convenience						✓							✓				✓		
Accessibility		✓		✓		✓		✓		✓	✓	✓		✓		✓	✓		✓
Tourism, Recreation		✓				✓				✓	✓	✓		✓					
Quality of Life		✓					✓			✓		✓	✓	✓		✓			✓
Innovative Financing		✓					✓						✓	✓	✓				
US-Internat'l .Connections		✓	✓	✓				✓		✓	✓			✓		✓	✓		✓
Land Use & Transportation		✓	✓	✓		✓		✓		✓	✓	✓		✓	✓		✓		
Management Systems		✓							✓		✓								
Improve Const. Techniques											✓								
Crime/Security				✓						✓		✓		✓					
DOT Work Force																✓			
Pay Debt Service																		✓	
Improve Rail			✓			✓								✓				✓	
Improve Aviation			✓			✓								✓				✓	
Improve Air Quality		✓												✓	✓			✓	
New Construction									✓										

Source: *State Transportation Plan Review*, NTS Framework/USDOT Restructuring Process

Table 2.2 presents these categories of goals and objectives, and the more specific topical areas that are associated with each.

Several statewide plans recognized the need to improve customer service and develop a user-oriented transportation system. Consequently, customer service was added to the general categories for goals and objectives shown in Table 2.2. Iowa's Transportation Plan, for example, is characterized as a report to Iowa's "transportation customers." In Missouri, "The Long-Range Transportation Plan will ensure that the Missouri Highway and Transportation Department proactively involves its customers from both the public and private sectors in the transportation decision-making process."[8]

One of the most extensive uses of customer satisfaction measures to date has been undertaken by the Minnesota Department of Transportation (see box, below) where customer surveys will provide a significant portion of the data needed to generate performance measures. Another innovative customer service-oriented measure has been proposed for the Michigan CMS. The proposed measure is a log of consumer complaints classified by type and location to reflect the qualitative aspects of system performance. Also, in addition to standard performance measures, the Michigan CMS will allow the user to define custom performance measures through its ad hoc query capability and linkages to other management systems.

As shown in Table 2.2, all of the more specific topics can be related to one or more of these general categories. For example, congestion is relevant to both environmental quality and economic development. Also, concerns about stable funding sources for transportation appeared often enough to warrant its own general category, but the need for equity in the funding mechanism was also recognized by several goals. Thus, goals and objectives may overlap in several categories, suggesting that multiple performance measures might be used to track an issue (e.g., funding) from more than one view point, allowing decision-makers to "triangulate" on a best compromise solution where different users have different desired outcomes.

For example, the general goal of congestion reduction might result in one objective statement addressing economic development, such as "manage or reduce roadway congestion in the periods surrounding the peak hours" to maintain the economic viability of local and regional surface freight operations. A second objective statement addressing system efficiency might be "manage roadway congestion to a level consistent with efficient utilization of multimodal system capacity" which is aimed more directly at equilibrating congestion levels (and thus travel times or costs) among competing alternative modes. Each objective statement can be supported by performance measures which track different data, e.g., off-peak travel times n truck routes, versus differential travel times for defined trips in corridors with competing modes.

[8] Missouri Long-Range Transportation Plan policy document.

Table 2.2 Issue Categories for Goals and Objectives

Economic Development
- New Technology
- Congestion
- Freight/Passenger Coordination
- Rural Development
- Tourism, Recreation
- Quality of Life
- International Connections
- Improve Rail
- Improve Aviation
- New Construction

Environment
- Congestion
- Non-Highway Modes
- Multimodal Alternatives
- Land Use & Transportation
- Improve Air Quality
- Energy

Safety
- Crime/Security

Efficiency
- Cost Reduction
- Congestion
- Freight/Passenger Coordination
- Non-Highway Modes
- Multimodal Alternatives
- Improve Planning Process
- Intermodal Efficiency
- Energy
- Improve Construction Techniques
- DOT Work Force

System Preservation
- Management Systems

Mobility
- Non-Highway Modes
- Multimodal Alternatives
- Convenience
- Accessibility

Equity
- Community Values
- Rural Development
- Non-Highway Modes
- Multimodal Alternatives
- Improve Planning Process
- Quality of Life
- Land Use & Transportation
- Public Involvement
- Mobility Disadvantaged

Stable Funding
- Public/Private Partnerships
- Innovative Funding
- Pay Debt Service

Customer Service
- Customer Perceptions of Organization and System Performance

Focusing on the Customer – Mn/DOT's "Family of Measures"

The Minnesota Department of Transportation (Mn/DOT) began its current Strategic Management Process in 1992 to involve citizens in clarifying transportation issues and needs. As a result of that process, Mn/DOT produced their *Family of Measures*, an organizational performance measurement framework, in 1995. This document presents the following vision for Mn/DOT: "to pioneer, from the *customer's* (emphasis added) viewpoint, a seamless transportation system that offers more choice, flexibility, and ways of moving people and goods."

The *Family of Measures* also presents some valuable core concepts of Mn/DOT's performance measurement philosophy. One concept notes that "a well known principle of measurement states that what is measured gets most of the attention. The right measures, then, provide strong reinforcement of the key results that Mn/DOT wants to achieve." A second provides some criteria for good performance measures. Mn/DOT asserts that the best measures are:

- Directed at what the customers think is most important;
- Aligned to support organizational priorities and strategies;
- Part of a family that is not too large or too small;
- Not always easy to implement, taking some work;
- Developed by the people closest to the work; and
- Providing frequent feedback to those doing the work leading to improvement.

With the *Family of Measures,* Mn/DOT has demonstrated an innovative, strategic approach to measure, track, and evaluate whether customer needs and public goals are being met with the most efficient use of resources. Customer satisfaction will be measured at least in part through market research surveys which will determine customer perceptions of system performance (e.g., condition, safety, commute time), public values and issues (e.g., satisfaction with air quality, promises kept on project completion), and organizational performance (e.g., employee satisfaction with diversity efforts, management perception of progress).

Source: Minnesota Department of Transportation, *Family of Measures*, February 1995.

2.2.4 Example Goal and Objective Statements by Category

Review of the many planning documents revealed almost as many styles in formulating goal and objective statements. One MPO's "goal" may be another state's "objective." This can present a stumbling block for developing a performance-based planning process, since the process begins with goals and objectives, and includes multiple checks and feedback loops to monitor progress toward meeting those goals and objectives. To gauge the breadth of agency approaches and to seek to reconcile contrasting styles, we built on the definitions presented above. We inventoried examples of goal and objective statements currently used in practice, and present them in Table 2.3. In some instances, we moved a stated "goal" into the "objective" category, or vice versa, so that the statements are consistent with our proposed definitions. The examples help to further illustrate the incrementally more specific and quantifiable nature of objectives relative to goals.

Table 2.3 Example Goals and Objective Statements by Category

Category	Goal	Objective
ECONOMIC DEVELOPMENT	• Address anticipated demand from increase in international trade. (Montana IMS)	• Improve access to passenger and freight facilities to serve international markets. (New Jersey's "Transportation Choice 2020")
ENVIRONMENT	• Develop projects that are environmentally acceptable. (Alaska Intermodal Transportation Plan)	• Improve air quality in Texas through transportation measures. (Texas Transportation Plan)
SAFETY	• Ensure high standards of safety in the transportation system. (Mississippi Statewide Transportation Plan)	• Reduce the rate of motor vehicle crashes, fatalities, and injuries, and bicycle and pedestrian fatalities and injuries on highways. (2020 Florida Transportation Plan)
EFFICIENCY	• Develop strategies that improve the transfer of people and goods between modes, private facilities, and publicly owned systems by reducing delays and minimizing inconvenience, thus providing a more "seamless" transportation system. (Tucson, Arizona IMS)	• Utilize economies of scale by providing for joint use of ports by several tenants. (West Virginia Statewide Transportation Plan)
SYSTEM PRESERVATION	• Preserve the highway infrastructure cost effectively to protect the public investment. (Washington Statewide Multimodal Transportation Plan)	• Improve construction techniques and materials to minimize construction delays and improve service life of transportation improvements. ("Access Ohio," Ohio's Statewide Plan)
MOBILITY	• Work with the general public, public agencies, and private sector organizations to ensure basic mobility for all Michigan citizens by, at a minimum, providing safe, efficient, and economical access to employment, educational opportunities, and essential services. (Michigan Long Range Plan)	• Make public transportation travel time competitive with autos. (Oregon IMS)

Table 2.3 Example Goals and Objective Statements by Category (continued)

Category	Goal	Objective
EQUITY	• Cooperate with Vermont residents, towns, regions, and other state agencies and interested parties in making transportation decisions that balance the needs of the human and natural environment. (Vermont Long Range Transportation Plan)	• Modify the Access Management Plan to provide more clear guidance and emphasize the sharing of responsibilities with local jurisdictions. (Montana Statewide Intermodal Transportation Plan)
STABLE FUNDING	• Provide stable and flexible transportation funding. (California Transportation Plan)	• Seek to obtain more funding through non-traditional sources such as grants and foundations. (South Carolina Intermodal Transportation Plan)
CUSTOMER SERVICE	• Optimize transportation investment by focusing on customer satisfaction. (Minnesota DOT "Family of Measures")	• Maximize information on service availability and intermodal options (Metro, Oregon DOT, Port of Portland "Intermodal Management System Scope Development")

2.2.5 Performance Measures

The way in which an agency decides to measure system or facility performance will have a profound impact on the types of projects which one implements in order to enhance performance. For example, one concern with the California Congestion Management Program (CMP)[9] is its use of roadway level of service (LOS) as the only mandated measure of system performance; projects which enhance LOS would be given priority by virtue of this definition of system performance.

Many agencies are now striving to avoid California's problem by defining several measures, rather than trying to define system performance through one measure. The ISTEA management systems effort is partly responsible for a rapidly expanding awareness of the value of moving to more numerous and broad measures of system performance. For instance, as part of Ohio's Congestion Management System (CMS), performance measures will include, as a minimum, LOS, travel time, transit load factors, delay, person-hours of travel, and a congestion index. Other agencies are also following this example, but are following a tiered approach in which use of more "innovative" measures will be phased in as data collection programs are modified to better fit the needs.

Dimensions of Transportation Performance Measures

Performance measures may be characterized along a number of dimensions. These many dimensions make the exercise of performance-based planning a difficult one. Performance measures may be related to the broad policy topics described in the previous chapter. This dimension is the most direct link of performance measures back to policy goals and objectives. Performance measures may also be classified according to whether they are multimodal or mode-specific, by whether the measures are applicable to freight or passenger transportation, by the system level to which they apply (systemwide, corridor, or facility), by the planning jurisdiction to which they are most relevant, and by their perspective. The perspective of a performance measure may be that of the user or that of the agency or operator.

It is instructive, therefore, to consider these dimensions in developing, selecting, and implementing a set of performance measures in a planning process. Not only may it help reduce analytical effort by eliminating some irrelevant performance measures, but it will also ensure that adequate breadth is instilled in the planning process so that all relevant issues are addressed.

Based on the research, the following dimensions of performance measures were identified:

- **Sector –** freight, passenger;
- **Mode –** highway (auto, truck, transit), pipeline, rail, water, intermodal, bicycle, walk, other non-motorized modes (electronic "modes" were also proposed by some);

[9] CMPs are prepared by local California governments acting at the county level through a "Congestion Management Agency." It is separate from the federal CMS process.

- **Perspective –** user versus supplier, condition versus performance;
- **Concern** – economic development, environment, safety, efficiency, system preservation, mobility, equity, stable funding;
- **Type of Application –** policy, regulatory, programmatic, implementation;
- **Spatial Concern –** metropolitan (urban versus suburban), rural, intercity/interurban, interstate, international;
- **Level of Responsibility –** federal, state, regional, local;
- **Use of Information –** management decision-making, diagnostic tool, tracking and monitoring, resource allocation, signaling systems between users and suppliers, information systems;
- **Timeframe –** present/short-term, future/long-term, point in time versus trend; and
- **Level of Refinement –** data item versus performance measure, primary versus secondary indicator, surrogate versus desired primary indicator, original versus pre-existing/secondary choice, primary versus composite measure.

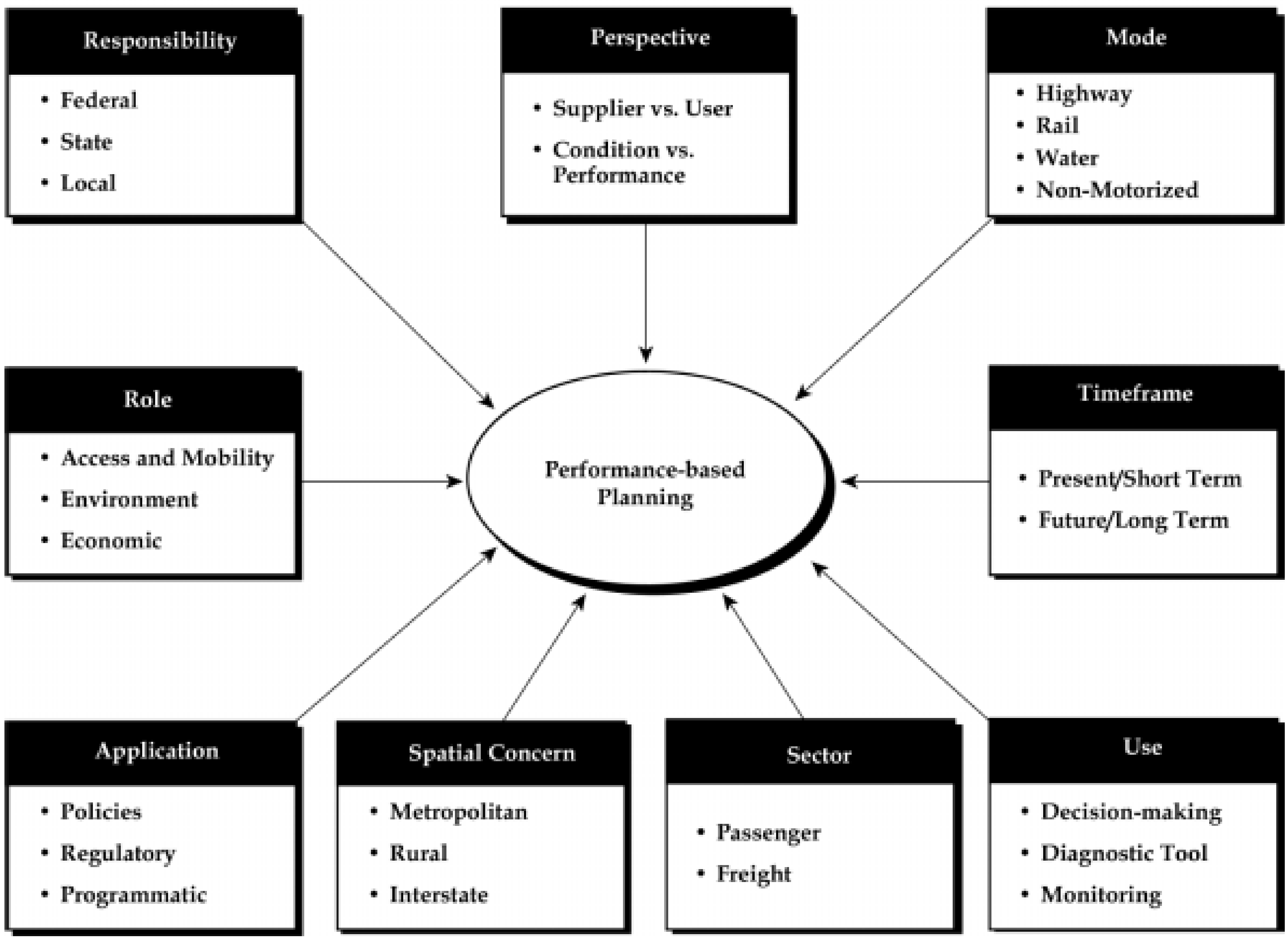
The categories in the dimensions listed above are not immutable. For example, the highway mode could be broken down even further into truck, bus, and auto. Most planning agencies categorize selected or proposed performance measures according to all or some of the dimensions listed above and shown in Figure 2.1. For example, the Michigan CMS workplan classifies proposed performance measures by system level (links versus systemwide trends), and by mode (highway, transit, person). The dimensions shown above are designed to encompass any number of classification systems.

Selection Criteria for Performance Measures

Several management system work plans and local and regional transportation plans laid out criteria for selecting performance measures as well as, or rather than, the measures themselves. These selection criteria are instructive as to agencies' concerns and the intended use of the performance measures. Agencies who used selection criteria usually were concerned with the actual "operationalizing" of the performance measures, and with the many different dimensions of performance measures listed in the previous section.

The following list presents common criteria for selection of performance measures and a discussion of each. It is adopted from a number of different sources, including Southern California Association of Governments' Regional Mobility Element, the Santa Clara County (CA) Subregional Deficiency Plan, and FHWA's *Analytical Procedures to Support a Congestion Management System.* Such a list can serve as a starting point to help planners select performance measures and balance the sometimes conflicting needs and limitations of decision-makers and analysts.

Figure 2.1 Dimensions of Performance Measurement



- **Measurability –** Is it possible to measure the performance measure with the tools and resources we have available? How much would it cost to adequately quantify this measure? What level of accuracy is needed for the measure to be useful? How reliable are the sources of data for this measure? Is needed data available?

- **Forecastability –** Can one realistically compare alternatives using this measure? Is it difficult to define this measure using existing forecasting tools?

- **Multimodality –** Does this measure encompass a number of different modes?

- **Clarity –** Is this measure understandable to policymakers? to transportation professionals? to the public?

- **Usefulness –** Is this measure useful? Is it a direct measure of congestion? Is it capable of diagnosing transportation deficiencies, i.e., a "triggering" device that will cause further study or action to occur?

- **Temporal Issues –** Is the measure comparable across time? That is, is it capable of expressing the magnitude, spatial, and temporal extent of congestion? Is it capable of discriminating between peak-period, off-peak, and daily congestion levels?

- **Geographic Scale –** Is the measure applicable to all areas of the state, region, local area? Can it discriminate between freeways and other surface facilities? Is it useful at a regional, subarea, or corridor level?

- **Multiple Indications of Goals** – How many of the project goals does the measure help to address? Is the measure relatable to thresholds that indicate how well the system is performing? Is it a measure of supply, demand, or both?

- **Control** – Is the characteristic capable of being controlled or corrected at the state and/or local government level?

- **Relevance** – Is the measure relevant to planning/budgeting processes? Does the reporting of these measures happen often enough to give decision-makers the information they need as often as they need it?

- **Ability to diagnose problems** – Is there a logical link between this measure and what actions/phenomena affect it? Is the measure too aggregated – to a level where a "black box" syndrome can occur?

Of course, selection criteria may vary from one agency to the next, depending upon need, resources, and capabilities. One common area of difference is in the degree to which agencies are willing or able to support new data collection procedures in order to implement new performance measures. We heard in the workshops and in our case studies that the cost and institutional obstacles to new data collection were an issue for many agencies, and a real "deal killer" for some. Therefore, some agencies will be most comfortable with measures that are readily quantifiable with existing data, and in most cases this will mean making do with a rather limited array of measures. Other agencies have already demonstrated a willingness to pursue useful measures of performance that required new data collection efforts, or which will be supported by "surrogate" data until new data collections programs can be put in place. Each agency should learn to apply these selection criteria in a framework that suits their particular need and situation.[10]

Performance Measures by Category

Table 2.4 contains a list of performance measures associated with the categories listed previously. The list is not intended to be comprehensive; rather, it presents examples of how performance measures are used in practice. The list of measures was developed from a number of state and local planning documents. The research showed a great deal of overlap in the measures proposed by different agencies for different purposes. A measure taken from a CMS work plan, for example, might be found in numerous other sources, including other management systems.

Composite Performance Index

The concept of a composite "performance index" has been suggested as an efficient means to compare multimodal alternatives or to otherwise allow comparison across one or more of the "dimensions" described earlier. There are a few agencies that are actively pursuing variations of this concept. Among them, SCAG uses index values to assess mobility, the environment, finance, economic development, livable community, safety, and quality of service. Their mobility index, for instance, is a composite value of VMT, operating speeds, free flow speeds, average vehicle occupancy, and population.

This concept was the topic of discussion at a recent Management Systems Integration Committee meeting.[11] This meeting was attended by representatives from the states of Colorado, Florida, Missouri, Oregon, California, and Michigan, as well as FHWA. Representatives from the state of Colorado presented a suggested approach to a composite performance index that sought to reconcile the competing priorities of safety, infrastructure preservation, mobility, etc. After much discussion, the committee found that the Colorado approach is one possible method for integrating results of management systems in a manner that will support the planning and decision-making processes.

The group expressed concern, though, that composite performance indexes should not be used for project selection or prioritization. Management system professionals were encouraged to work to ensure that overall scores of performance are used only at the system level for funding allocation decisions and reports of overall system performance and status.

This concept is still under debate at a number of different levels. Although the composite concept may not evolve into practice, the debate process is positive. The attempt to address a wide variety of issues on a common scale is the first step toward developing a more effective way to evaluate and reconcile difficult tradeoff decisions. Decision-makers have indicated concern about their ability to grapple with multiple simultaneous measures.

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[10] Pratt, R. and Lomax, T. *Performance Measures for Multimodal Transportation Systems,* presented at the 73rd Annual Meeting of the Transportation Research Board, Washington, DC, January 1994

[11] FHWA, *Management Systems Integration Committee Meeting*, Denver, Colorado, January 1995.

Table 2.4. Examples of Performance Measures by Category

Category	Example Performance Measures
Economic Development	• Jobs supported • Economic costs of pollution, accidents, fatalities, lost time • Number of structures with clearance below 15 ft. 6 in.
Environment	• Change in tons of pollution generated • Change in tons of greenhouse gases generated • Number of transportation control measures accomplished versus planned
Safety	• Accidents/person-mile • Accidents at major intermodal crossings • Bicycle accidents per bicycle-mile of travel
Efficiency	• Work trips completed per vehicle hour of commute travel • Cost per revenue hour of transit vehicle • Vehicle-miles of travel/person-miles of travel (VMT/PMT)
System Preservation	• Percent of roadway/bridge system below standard condition • Percentage of budget allocated to system preservation activities
Mobility	• Mobility index (PMT/VMT times average speed or ton-mi/veh.-mi times average speed) • V/C ratio (or LOS) • Lost time due to congestion • Percent of population within "X" minutes of employment
Equity	• Percentage of investment in non-urban areas • Percentage allocation to various modes
Stable Funding	• Percentage of committed funds for plans • Tax and fee revenues and trends
Customer Service	• Customer perceptions of safety • Frequency of service • Response time to incidents

■ 2.3 Experience in Other Fields

We evaluated the application of performance-based planning concepts in other fields in an attempt to identify relevant, transferable lessons or methods. Several industries are of particular interest because of similarities with the breadth of issues and objectives that transportation system performance must address. These included the electric utility industry, the service industry, and several governmental agencies involved in delivery of services other than transportation

In the electric power generation and distribution field, performance has historically been oriented to minimizing rates within a set of service reliability criteria and subject to a reasonable rate of return. Cost control, efficient use of existing capacity, accommodation of co-generation (private competition), or environmental impacts were not significant factors until relatively recent times. The industry's response has been integrated resource planning, or least cost planning. Least cost planning, like most performance-based planning methods, has required new analytical tools, institutional structures, and data collection methods. Establishment of "energy collaboratives" has brought together utilities, regulators, private industry, and environmental and citizen interest groups into a joint decision-making framework, and the performance measures being considered have changed dramatically. The prospect of significant industry deregulation will reinforce this trend. An important lesson from the electric utility industry is to apply new planning methods incrementally, rather than attempt to impose a grand new scheme all at once, as considerable time and resources are required to effect the necessary change in institutional and organizational structures as well as analytical capabilities.

We also found relevant examples of performance measurement in the service industry, where customer service and customer satisfaction are a current focus of efforts to improve performance. Similar to transportation, the service industry must deal with many market segments and external factors. Virtually every service organization has been affected by recent economic trends, the quality movement, and recognition that rapid change in telecommunication and information systems technology is creating new opportunities as well as new risks for management. The implications of these factors for performance measurement are important to consider, even if, in many cases, the specific performance measures used by some industries are not directly applicable in a transportation context. For example, private sector practices highlight the importance of developing *customer-oriented* rather than *institutionally-oriented* measures of performance. The public transportation sector has begun to appreciate this distinction only in recent years, as already noted.

Other non-transportation public sector efforts in performance measurement were evaluated, including government programs at the federal, state, and local levels which have been the target of performance audits and evaluations. Pilot studies, such as those specified in the Federal Performance and Results Act, may be an appropriate method for implementing least cost or other performance-based methods in transportation. From the public sector, non-transportation fields come useful concepts such as operational versus non-operational agency goals, measuring efficiency (output) versus measuring effectiveness (outcome), use of performance measures for external evaluation versus internal decision-making, and recognition of the need to account for external factors when making comparative evaluations of programs.

2.3.1 The Electric Utility Industry

Electric power in the United States is provided by a mixture of public and private companies subject to a variety of governmental regulation. Regulatory bodies control the rates charged to customers and the return on investment earned by utilities. This situation has led to a somewhat different perspective on overall performance than that of a purely private industry. Since the rate of return is fixed, revenue requirements per kilowatt hour produced (i.e., the utility's cost of doing business) serve as the overall indicator of performance.

Revenue requirements per kilowatt hour are used, for example, by investors assessing the performance of utility companies or by utility companies themselves for assessing their bottom line.

Although revenue requirements reflect performance, the determination of costs that a utility company may pass on to its ratepayers is not entirely free of regulation (this insulates ratepayers from poor management decisions). In addition to other rules, utility companies must follow formal planning processes to determine the best combination of resources to meet the demand for power. Historically, utilities strove to select the lowest cost combination of supply resources (power generation plants, transmission lines, substations, and transformers) to meet the demand while maintaining reliable and safe service.

Industry Changes

While the basic planning process described above has not changed, a number of external factors impacting the industry have shifted its focus over the past decades. In an environment of ever-increasing demand, an expanding economy, and stable fuel costs in the 1960s, the planning focus was on providing reliable service while expanding capacity. In the 1970s, stabilizing or declining demand for power, high inflation and interest rates, fluctuating fuel prices, and a stagnant economy shifted the planning focus to finding the lowest cost combination of supply resources. With the 1980s and 1990s came an oversupply of capacity, environmental concerns, technology permitting efficient long-distance transmission of bulk power, selective deregulation, and increasing competition. In response to these factors, electric utility industry planning processes have evolved into the present-day integrated resource planning.

Integrated Resource Planning

Integrated resource planning may be defined as an iterative process to find the lowest total cost combination of both supply and demand management[12] resources that is consistent with maintaining service reliability and, increasingly, customer satisfaction. Regulatory agencies in many states now require utility companies to submit Integrated Resource Plans (IRPs) in support of their rate base cases. Thus, IRPs are a key element determining revenue requirements or overall performance.

Integrated resource planning typically includes four basic steps:

1. Identification of goals and key issues that the resource plan must address – Typical goals might relate to customer service, environmental protection, or return to company shareholders. Issues could include the disposition of an aging power plant or modification of demand-side-management (DSM) programs.

[12]Demand management resources include conservation programs, the promotion of energy efficient appliances to consumers, pricing mechanisms, and other Demand-Side-Management (DSM) programs.

2. Development of alternative load forecasts – Utilities use either an econometric approach or an end use approach to this task which also includes peak-period forecasting. The econometric approach relates the power consumption of an aggregate class of customers to economic variables. The end use approach relates power consumption of end users to their individual characteristics. Forecasts account for existing demand-side-management (DSM) programs.

3. Identification of need for additional resources – Utilities assess the costs and remaining lifetimes of existing supply and demand side resources to determine whether they are adequate to meet the projected demand. Supply resources such as power plants, electricity purchased from other organizations, and transmission and distribution (T&D) options are considered at the same time as DSM measures.

4. Assessment of broad array of alternatives – Utilities analyze different combinations of supply and demand resources in terms of their total cost and other stated criteria such as public acceptability, reliability, or socioeconomic impacts. Again, both supply and demand side options are considered at the same time. To minimize risk, uncertainty analysis is a key component of this step.

While specific practices and analytical methods vary widely from utility to utility, a guide sponsored by Oak Ridge National Laboratory outlined the characteristics of a good IRP. These include:

- Comprehensive and multiple load forecasts which treat peak loads and establish clear relationships with DSM programs;

- Thorough consideration of the full array of supply options including T&D options, purchased power, and renewable energy sources;

- Integration of demand and supply options;

- Thoughtful assessment of potential impact or implications of the inherent uncertainty of certain assumptions, projections, etc.;

- A full explanation of the preferred plan and its closest competitors;

- Use of appropriate time horizons (two to three years for actions plans, 10 to 20 years for planning, and 20 to 40 years to account for impacts);

- A short-term action plan that adequately documents a utility's commitment to implement the long-term plan;

- Fairness (provision of information so that different interests can assess the plan from their own perspectives); and

- Clarity.

Not surprisingly, the practical application of integrated resource planning has presented considerable analytical challenges to the electric utility industry. Among the analytical issues utilities must consider when preparing IRPs are the selection of appropriate time horizons, the explicit treatment of uncertainty, estimation of avoided energy and capacity costs, explicit consideration of reliability and reserve margins, quantifying environmental costs, and the analytical integration of supply and demand side resources. An ongoing body of research is addressing such issues over time and the IRP process will continue to evolve.

Application to Transportation Planning

There are many similarities between the electric utility industry and the transportation sector. Both industries have traditionally been capital-intensive and involved large public works projects. Both electric power and transportation services are provided by a mix of public and private entities. The private sector providers of both electric power and transportation services have been subject to increasing competition over the past two decades. Finally, the impact of both industries on the environment is a major concern.

Given the similarities between the two industries, the concept of integrated resource planning holds much promise for transportation planning applications. Indeed, there has been considerable recent interest in the concept which, when applied to transportation planning, is usually termed "least cost planning"[13]. Least cost planning principles would meet many of the requirements of ISTEA, including those for multimodal planning, public participation, and consideration of demand side strategies.

While current transportation planning practice incorporates some elements of least cost planning, the critical distinction is that least cost planning "develops a more complete set of demand and supply options, encompasses a wider set of objectives, and involves the participation of a broader range of parties."[14] As attractive as the theory of least cost planning seems for transportation planning, a number of practical and analytical difficulties remain to be worked out.

These difficulties stem in part from differences between the electric utility industry and the transportation field. The transportation field involves a greater level of consumer choice and produces a much more complex mix of outputs than the electric utility industry, thus complicating the application of least cost principles. For instance, there is no single, agreed-upon unit of production to represent the output of transportation systems. In energy planning, a megawatt saved is equivalent to a megawatt produced. In transportation, one of the more common "generic" output measurements is the passenger mile (or ton mile in the case of freight) but these units do not reflect accessibility, mobility, or qualitative considerations.

A study sponsored by the Washington State DOT outlines some of the practical barriers to implementing least cost planning principles to transportation. One major barrier listed

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[13] The term "least cost planning" arose because the technique is intended to bring about the lowest total cost combination of supply and demand side components.

[14] Hanson, Mark, Stephen Kidwell, Dennis Ray, and Rodney Stevenson. "Electric Utility Least Cost Planning: Making It Work within a Multi-attribute Decision-Making Framework" *Journal of the American Planning Association* (57: 1), 34-42, Winter 1991.

was the lack of knowledge about consumer response to demand management strategies. The electric utility industry has much better information about consumer response to DSM simply because it has performed the necessary research (this barrier could be overcome in time). The study also cited a lack of analytical tools for analyzing comprehensive sets of alternatives, a lack of information on the total costs and benefits of travel, the political nature of transportation planning, and poor inter- and intra-agency coordination as barriers to least cost planning.

Apart from much academic attention, least cost planning principles have yet to be fully implemented by public transportation agencies. In the state of Washington, legislation passed in March 1994 requires regional transportation planning organizations (RTPOs) to use least cost planning methods in developing regional transportation plans. The legislation did not, however, offer any definition of least cost planning concepts or specific analytical methods. Development of guidelines and specific analytical procedures for the state is being overseen by the Puget Sound Regional Council (the MPO for the Seattle area). At present, there is not yet a body of practical implementation experience to draw upon. The Oregon Department of Transportation has also shown some interest in least cost planning, sponsoring a feasibility study on the subject. The feasibility study will be followed by a least cost planning case study to develop recommendations and implementation procedures.

Summary of Least Cost Planning Applications

Before applying least cost planning to transportation or even before developing analytical methods or models a number of changes must occur within the field. First, transportation planners and decision-makers must agree upon the definitions of least cost planning concepts. The means for costing various supply and demand options must then be agreed upon. Methods, procedures, and interagency coordination in the planning process would have to be improved. Finally, a set of performance measures to be used in comparing resource combinations must be agreed upon.

While the idea of least cost planning raises significant analytical challenges, it is both relevant and applicable to the transportation field as a conceptual framework. Perhaps the most significant lesson taken from the electric utility industry is that ideas like least cost planning should be implemented incrementally. Even after 10 years of development, least cost planning principles and practices are not fully standardized or agreed upon within the utility industry. With many people working on the same issues, however, the analytical problems will be solved over time. While the temptation is to implement least cost planning in one grand effort, an incremental approach will probably be more successful in translating least cost planning principles into practical performance-based planning methods.

As a final note, Least Cost Planning has its share of skeptics in the transportation planning arena. Integration of a sophisticated analytical process into the highly political transportation decision-making process may presume that we can rationalize the process to a higher degree than is realistic. One opinion states that we should incorporate these methods only as a guide in ranking projects or programs. We should first gain additional experience with these methods in cross-modal and interjurisdicitonal tradeoff applications, before attributing to them too much conflict-resolving power.

2.3.2 The Service Industry

Service industries are those included in Sections 6 through 9 of the Standard Industry Classification (SIC). They treat people or provide goods or facilities for them. The service sector is diverse, spanning industries such as tourism, financial services, health care, catering, and communications.

Service organizations have devoted increasing attention to concepts such as quality and customer service and the relationship between quality, customer satisfaction, productivity, and profitability are being explored. In this arena, "Good performance is defined as successfully achieving high resource utilization with a high level of customer service whilst meeting the cost and profit requirements of an organization. Thus, private companies are starting to recognize that productivity (i.e., efficiency) alone will not lead to profitability."[15]

Some useful concepts may be drawn from recent literature on the subject. First, service quality may be measured internally, using a company's internal monitoring systems or externally, using customer surveys and questionnaires. Service quality may be measured before, during, or after service delivery (for example, customers may be involved in specification of a product or service before it is delivered). Complaints are said to be a very poor measure of service quality since 65-90 percent of dissatisfied customers do not complain but merely do not patronize the business again, or do so less frequently.

One way service quality, productivity, and financial profitability may be linked together in service organizations is through establishing performance standards or targets. There are a number of types of performance standards including historical standards, internally-based standards (e.g., resources consumed to deliver a certain product), competitor-based standards, absolute standards, and best-in-field standards or benchmarks. Increasingly, however, organizations are moving towards customer-oriented standards. As an analogy, a highway department might move from measuring tons of salt spread on roads to measuring user safety by the number of accidents caused by ice.

Approach to Performance Measurement

Service sector managers approach performance measurement and control by focusing on four key characteristics of the industry that make the service sector distinct from a more tangible product-based industry (e.g., manufacturing). These qualities are:

- Intangibility,
- Heterogeneity,
- Simultaneity, and
- Perishability.

[15] Fitzgerald, Lin, Johnston, Robert, et al. *Performance Measurement in Service Business,* the Chartered Institute of Management Accountants, 1991.

First, most services are *intangible*. They may be performances rather than objects. Second, because service outputs are *heterogeneous*, the standard of performance may vary, especially where a high level of labor is involved. It is hard to ensure consistent quality from the same employee from day to day, and harder still to get comparability between employees – yet this will crucially affect what the customer receives.

Third, the production and consumption of many services are *simultaneous* in their production and consumption, for example, getting a haircut. Some elements of the service delivery process therefore cannot be counted, measured, inspected, tested, or verified in advance of sale for subsequent delivery to the customer. Fourth, services are perishable; that is, they can not be stored. *Perishability* thus removes the inventory buffer frequently used by manufacturing organizations to cope with fluctuations in demand. Therefore scheduling operations and controlling quality are key management problems in services, which are made more difficult by the presence of the customer in the service process. Although the simultaneity of production and consumption enables cross-selling and the collection of feedback from customers in real time, an unfavorable impression of the service process may erode a customer's satisfaction with the service product.

Taken together, these four characteristics pose a unique set of problems for service managers. They will also affect the process of performance measurement, not so much in terms of *what* is measured, but *how* it is measured.

Key Aspects of Service Performance

Evaluating and developing service operations involves the linking of three areas: quality, resource utilization (productivity), and cost and profit (financial performance). The challenge for service operations managers is not only to use their resources as efficiently as possible, even in times of budget constraints and downsizing, but to manage their resources to provide a high level of customer service. Of greatest interest to the transportation community are the quality and productivity aspects of service performance measurement. The following paragraphs summarize these aspects.

Service Quality Measurement

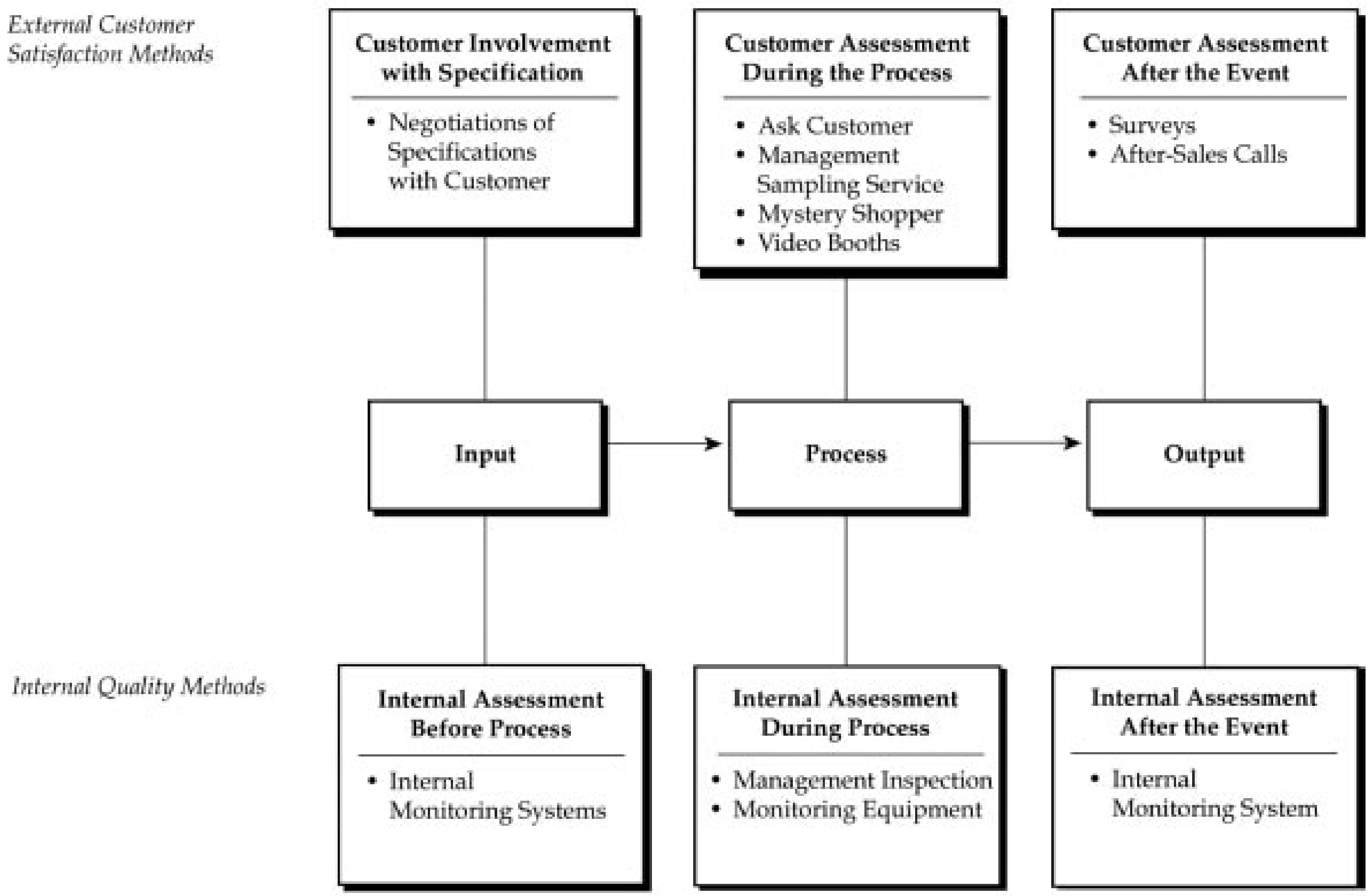
The measurement of service quality can be based on information collected from two different data sources. First, it can be measured *internally,* using the company's own internal control systems. Second, service quality can be measured *externally,* using customers' assessment of the level of service provided (through surveys and questionnaires, for example). Furthermore, service quality can be measured at the various stages in the service delivery process – at the input stage, during the process of service delivery, or after the service has been provided (i.e., the output stage). Service quality measurement methods at these various stages are shown in Figure 2.2.

Service Productivity Measurement

Resource utilization is often measured by service firms in terms of productivity, that is, a ratio of inputs to outputs:

- Productivity = Outputs/Inputs

Figure 2.2 Quality Measurement Methods in the Service Industry



Improving productivity can be achieved by reducing the level of inputs, increasing the level of outputs, or both. There are many different measures of output/input ratios which can be used in service organizations.

Service organizations struggle with a number of problems when they attempt to measure productivity. These problems are:

- Some service activities are not concerned with transforming inputs into outputs;
- Outputs may be difficult to quantify due to the intangible nature of the service;
- The number of services provided may be a poor indicator of the amount of service provided; and
- Cost tractability may be difficult.

The fact that it is difficult to measure productivity does not, however, make it any less important as a performance criterion. Service organizations may choose one or more input/output ratios as part of their range of business performance measures.

Choosing a Range of Performance Measures

In choosing a range of performance measures, service organizations are careful to balance the measures to ensure that all of the various dimensions of performance receive adequate representation in the evaluation process. For example, a decision to upgrade quality may have a short-term adverse affect on profitability because of the costs incurred, but it may lead to greater customer loyalty and a long-term gain in market share and profits. An analogy is found in highway construction and maintenance, where the best long-term use of short-term resources may be in the maintenance of an existing facility rather than the construction of a new facility. Maintenance of an existing roadway facility while it is still in fair to good operating condition is far more cost-effective than waiting until many layers of roadbed are damaged.

Since much of service is intangible, it is difficult to measure performance in some areas. "Hard" measures such as profitability tend to drive out "soft" measures like customer satisfaction, even though the intangible aspects of services may be important sources of competitive advantage. Monitoring the amount spent on these intangibles may be vital to competitive success, particularly as advanced technology gives consumers more immediate access to competitors' services.

Service firms are beginning to expand their outlook beyond easily quantifiable aspects, such as cost and productivity, to other criteria which are important to competitive success. These aspects are synthesized into six generic performance dimensions:

1. Competitiveness;
2. Financial performance;
3. Quality;

4. Flexibility;

5. Resource utilization; and

6. Innovation.

Table 2.5 presents these six performance dimensions in terms of the key issues that each one addresses, and matches them to examples of performance measures that reflect each of the dimensions. A comparison of these dimensions to those commonly used by public-sector transportation agencies reveals some marked differences. For example, innovation, as a specific measure of performance, is often underemphasized or overlooked in public transportation planning. This is perhaps because innovation itself is not perceived to be a cause of improved quality.

Criteria for Selecting Key Service Performance Indicators

Service firm managers are learning that monitoring too many performance indicators can cause important information to be lost in a sea of data (see box, below.) The selection of a manageable set of key performance indicators therefore becomes important. The following criteria are commonly used to select a set of performance measures for service industries. They should:

- Be sensitive;
- Be important to customers;
- Cover the main strategic area of the business;
- Be significant for success/failure;
- Include quality, productivity, and finance measures;
- Be developed/selected by all levels of management; and
- Be limited to a manageable number of measures.

These criteria show the emphasis that service industries have on the customer. They also show that performance measurement process is an integrated part of the strategic planning process of the firm, as all levels of management are involved with their development, and they relate to the main strategic area of the business.

Indeed, part of the difficulty in identifying a finite set of performance measures for use in the public transportation sector is the overly-wide range of roles or "public goods" that we have come to expect from the transportation system. Our main strategic business area, i.e., movement of people and goods, must share the stage with other roles much as redressing economic inequities imposed by society, or providing for the economic health of a region. While many service businesses are able to externalize certain costs and impacts, the publicly-provided transportation system must increasingly account for and address such externalities, and even the undesirable side-effects of non-transportation activities. All of this complicates the process of selecting a manageable set of measures which address an acceptably-broad set of issues.

Table 2.5 Performance Measurement in Professional Services

Key Issues	Performance Dimension	Examples of Measures
• Ability to win new customers • Customer loyalty	COMPETITIVENESS	• Percent (%) success in tendering • Percent (%) repeat business • Market share relative to key competitors
• Control of staff costs • Tracing of labor hours to individual jobs to aid pricing decisions	FINANCIAL PERFORMANCE	• Staff costs • Debtor and creditor days • Value of work in progress • Profit per service
• Relationship building between customer and individual staff • Negotiation of project specification with customer • Measurement of customer satisfaction: use of Unstructured, informal methods	QUALITY	• Investment in training % non-chargeable: chargeable hours • Adherence to project specification and delivery promise • Customer satisfaction with various aspects of service
• Management of short-term volume, specification and delivery speed flexibility • Provision of flexibility through job scheduling, multi skilling, job rotation and staff discretion in dealing with customers	FLEXIBILITY	• Percent (%) orders lost due to late delivery • Staff skill mix • Percent (%) hours bought in from other offices • Customer satisfaction with delivery speed
• Control of front office staff time	RESOURCE UTILIZATION	• Ratio of hours chargeable to client and non-chargeable hours • Ratio of supervisors to staff
• Measurement of the success of the innovation process and the innovation itself	INNOVATION	• Number of new services • New service introduction lead time • Percent (%) training spend invested in new services

Too Much Data, Too Little Information

One unintended side effect of the information technology revolution is that businesses are collecting reams of facts but deriving limited useful knowledge about their operations. In the opinion of logistics experts, businesses need to turn the focus to information, not data. The same is probably true for many planning agencies launching ISTEA-era Management Systems and data collection programs. In the words of Dale S. Rogers, director of the University of Nevada's Center for Logistics Management, "Data is a raw stream of facts; information is what you have after you've had time to think about it for awhile. It's like any raw material. It doesn't have as much value as it does after it has gone through the manufacturing process."

The advent of networked information systems has made it more difficult for many planners and operators to figure out what is relevant and what is not. In response, the trend in businesses who are aware of the problem is to provide people with the information they need, no more and no less. The difficulty is finding that balance between no more and no less. As in private business, public transportation planning agencies need to assess what they need to know to "do business" and then develop a supporting plan of information technology. In the world of performance-based planning, this means identifying the appropriate performance measures needed to answer the basic question of whether progress is being made towards important goals and objectives, and then defining specifically those data required to generate and track the measures.

Source: Adapted from A. Saccomano, in *Traffic World*, April 17, 1995.

Customer Orientation

As mentioned, customer orientation is a key aspect of the success of service organizations. Performance measures are used to address mismatches between the key gap in the service delivery process – what the organization measures and what its customers see as important. The performance measurement process, therefore, must start by defining precisely the bundle of services that the organization promises to provide. Then, the process must provide information to managers about how well that that bundle of services is being provided.

Measure What You Promise to Deliver

In *Moments of Truth*, Jan Carlzon of Federal Express writes, "We had caught ourselves in one of the most basic mistakes a service-oriented business can make: promising one thing and measuring another. In this case we were promising prompt and precise cargo delivery, yet we were measuring volume and whether the paperwork and packages got separated *en route*. In fact, a package could arrive four days later than promised without being recorded as delayed. Clearly we needed to start measuring our success in terms of our promises."

Application to Transportation Planning

The key difference between performance measurement in service industries and performance measurement in transportation is that the current research on the service sector focuses on private industries, where the overriding motive is profit. In transportation planning, on the other hand, the process is seldom guided by a profit motive alone, since most transportation planning activities are performed by the public sector. This difference aside, there are some key parallels between the service and transportation sectors, from which emerge some considerations for development of the framework:

- Performance measures must reflect the satisfaction of the transportation service user.
- Measuring performance before, during, and after the delivery of a transportation service can have profound effects on the organization's ability to diagnose problems and develop solutions.
- An understanding of the relationship between internal performance measures (crew sizes, overtime hours worked, etc.) to external performance measures (vehicle hours of delay due to incidents, transit ridership, etc.) is another key to improving the outcome of a given level of effort.
- Given the significant involvement of people in the transportation service delivery pro??cess, performance measures must accommodate variations in individual skills, productivity, and quality.
- Since most transportation services are simultaneously produced and consumed, there are significant opportunities for collecting feedback from system users in real time.
- Although "soft" measures, such as customer perceptions of safety, are more difficult to measure than "hard" measures, such as number of highway accidents, transportation agencies should not neglect them.
- The performance measurement process should balance long- and short-term system needs, and should recognize the periodic need to exchange short-term results for long-term benefits.
- A package of performance measures should be sensitive to system improvements, be developed and selected by all levels of management, and be limited to as small a number of measures as will meet the demonstrated information needs of those involved.
- The performance measurement process must start by defining precisely the bundle of services that the organization promises to provide. In planning, this means defining carefully the goals and objectives in statements that can be operationalized. Then, the process must provide information to transportation decision-makers about how well that that bundle of services is being provided, by monitoring performance measures that are clearly linked to the service objectives.

2.3.3 Non-Transportation Public Agencies

A broad-based literature review produced some general points on performance measurement in the public sector that could be used to organize thinking on the topic for transportation. First, it is useful to recall that public agencies cannot measure their performance with the single indicator of profit. Because public agencies provide services that for any number of reasons are not provided by the private market, performance must instead be measured against the goals and objectives of the agency or program in question. These may include goals that are equivalent to profit in the agency's "currency", but will rarely be as simple as maximizing net income.

Operational versus Non-Operational Goals

The first step in developing meaningful measurements of performance for public agencies is often to convert "non-operational" goals into "operational" goals. An operational goal is an imagined future state that can be unambiguously compared to the existing situation. A non-operational goal is a desired future state that cannot be compared unambiguously to the present state. To use an example from the criminal justice field, "reforming criminals" is a non-operational goal; "doubling the rate of inmate participation in prison programs" is an operational goal.

Efficiency versus Effectiveness

Once performance indicators have been developed, there is a distinction between *output* measures and *outcome* measures, which are analogous to the concepts of efficiency and effectiveness. Output measures reflect the quantity of resources used and the activities performed by an organization. Outcome measures, on the other hand, reflect the *success* of an agency or program *in meeting its stated goals and objectives*. For example, a law enforcement output measure might be numbers of arrests made or crimes investigated. Examples of outcome measures might include response time or citizen satisfaction. Table 2.6 lists examples of output and outcome measures gathered by a recent Congressional Budget Office study which help illustrate this concept.

Historically, public agencies have focused on measuring outputs rather than outcomes because of the difficulties associated with measuring outcomes. First, agencies and their constituents must define an agreed-upon set of goals and objectives, often a difficult task. Then, there is the problem of developing measures that meaningfully reflect outcomes. At this stage, agencies often resort to using output measures because they are concrete, easily quantified, and objective.

Once adequate performance outcome measures are developed, the question of causality remains. For example, a job training program might define as its performance outcome measure the number of participants who are employed six months after completing the program. Even if this statistic were accurately tracked, one could question whether the participants found jobs due to the training or simply because of an upturn in the economy. Isolation of external factors to the maximum extent feasible is desirable to ensure that outcome measures are reasonably precise indicators of changes in the measured activity.

Table 2.6 Examples of Output and Outcome Measures for Selected Programs

Output Measure	Outcome Measures
Elementary and Secondary Education	
Student-Days	Test Score Results
Student Graduated	Percentage of Graduates Employed
Dropout Rate	
Hospitals	
Patient-Days	Mortality Rates
Average Length of Stay	Patient Survey Results
Admissions	Readmission Rates
Public Transportation	
Vehicle Miles	Population Served (Percent)
Number of Passengers	Late Trips (Percent)
Police	
Hours of Patrol	Rates at Which Cases are Cleared
Crimes Investigated	Response Time
Number of Arrests	Citizen Satisfaction
Public Welfare Programs	
Number of Requests	Applications Processed in 45 Days
Amount of Assistance	Payment Error Rates
Road Maintenance	
Miles Resurfaced	Lane-Miles Improved (Percent)

External Evaluation versus Internal Decision-Making

Performance measurements are applied to at least two distinct types of applications. The first category involves evaluation of a program or agency by someone outside the organization. Such external evaluations are often peer comparisons that measure the efficiency of one agency or program to others of its kind. The second category involves the use of performance measures for decision-making within an agency or organization. Ranking capital investment alternatives, evaluating programs, and allocating a given level of resources within an agency are the types of internal decision-making that performance measures may assist.

Performance-based budgeting is a performance-based planning method that could be a subset of either of the categories described above. Where traditional public budgeting procedures have often allocated resources on the basis of the severity of the problems (e.g., when crime rates rise, prison budgets are increased), performance-based budgeting attempts to set budgets for programs and agencies based on desired program outcomes.

Several problems with the concept have been pointed out. Using performance-based budgeting to allocate resources among different types of programs requires an understanding of how to compare and tradeoff measures of their performance. Also, an underfunded program may perform poorly simply due to its underfunding while a successful program could see its resources cut or frozen.

2.3.4 Performance Measurement in the Federal Government

Recent surveys by the Congressional Budget Office and General Accounting Office have investigated the use of performance measures in federal agencies. In general, the study found that agencies have difficulty linking performance measures with their budget processes, that true measurement of outcomes was relatively rare, and that performance measurement systems function best where clear cause-and-effect relationships exist between the activities or outputs of an agency and the desired outcomes.

Since publication of the CBO and GAO studies, the Government Performance and Results Act of 1993 has given new impetus to performance measurement in federal agencies. The Act requires that heads of each federal agency submit a strategic plan to the Office of Management and Budget and the Congress by September 30, 1997. The strategic plans are to include:

- "A comprehensive mission statement" for the agency;
- "General goals and objectives, including outcome-related goals and objectives..";
- "A description of how the goals and objectives are to be achieved, including a description of the...human, capital, information, and other resources" required;
- A description of how performance goals (required by another section of the law) relate to the goals and objectives;
- An identification of factors beyond the agency's control which could affect its performance; and
- A description of the program evaluations used in establishing or revising general goals and objectives, and a schedule for future program evaluations.

By the fiscal year 1999, each agency will be required to submit an annual performance plan containing performance goals; an expression of the goals in an "objective, quantifiable, and measurable form"; a description of the resources required to achieve the performance goals; performance indicators to be used in measuring or assessing the relevant outputs, service levels, and outcomes of each program activity; a basis for comparing actual program results with the established goals; and the means for verifying measured performance values. The law does excuse agencies from expressing goals in "objective, quantifiable, and measurable form" if doing so is infeasible.

Beginning no later than March 31, 2000, each agency is required to submit an annual program performance report to the President and the Congress. These reports will use the methodology laid out in the strategic plans and performance plans to measure actual performance against targeted performance for the previous three fiscal years (by 2002). If goals are not met, agencies must explain why, including explanations where goals turn out to be infeasible.

The Government Performance and Results Act also includes provisions that give greater accountability and flexibility to managers in meeting performance goals. Beginning in 1999, performance plans may include proposals to waive administrative procedural requirements and controls. Provisions of the Act may be altered depending on the results of a pilot studies on performance measurement, managerial accountability and flexibility, and performance budgeting to be carried out between fiscal years 1994 and 1998.

The provisions set out in the Act show that the federal government is using performance measures to inform rather than dictate the budget-making process. Performance-based planning methods are being implemented in a measured and flexible fashion and may be modified or done away with if the pilot studies do not produce good results. This approach is appropriate given the untested nature of the performance-based planning methods in most public agencies, and is advisable in implementation of performance-based planning in public transportation.

2.3.5 Performance Measurement in State and Local Governments

A series of recent Government Finance Officers Association (GFOA) research papers addresses the use of performance measurement by state and local governments in their budgeting processes. This section summarizes the findings of those reports.

Performance measures have been used in state and local government budgeting for some time. They make up a portion of the wide array of financial and non-financial data used to evaluate budget requests and monitor budget results. In some instances, they serve as the principle basis for resource allocation decisions.

A portion of the GFOA research effort examined the use of performance measures in operating budgets submitted by state and local governments to the GFOA's Distinguished Budget Presentation Awards Program. A smaller, more homogeneous sample of budgets was drawn from those documents for more extensive analysis.

Findings

Of the 554 budgets screened, 330 (60 percent) of the documents included performance measures. The more in-depth analysis of 43 city and county budgets produced the following findings:

- The use of performance measures in budgets can vary widely from jurisdiction to jurisdiction, from a low of 79 measures to a high of 4,326 measures. On average, budget documents contained 601 performance measures.

- The greatest portion of performance measures found in these budgets were output measures, which made up an average of 70 percent of the total number of measures.

- Generally, as the size of the jurisdiction increases, so does the number of indicators used in the budget. No correlation was found, however, between the use of specific indicator *types* and population size of the jurisdiction.

- The largest number of indicators, about 40 percent of the total, were associated with general government activities. The greater use of performance measures for these activities may be explained by the ready availability of indicators for administrative activities and the influence of chief executives and administrators over those activities.

Conclusions

Although it was not possible to generalize these findings to local governments as a whole because of the relatively small sample size, the following conclusions can be drawn about the use of performance measures in budgets from these and other research efforts.

- Only those performance measures that provide useful and practical information for key functions and activities should be included. Since the cost of data collection and reporting can be high, it may be impractical to provide performance data for every government activity.

- Performance measures should be linked to long-standing budget objectives. To measure program effectiveness and efficiency over time, decision-makers should be provided with performance data for budget objectives that are established for consecutive budget periods.

- Performance data should be disaggregated at the same level and covering the same fiscal years as is done for other budgetary information. As a result, performance data may be afforded the same consideration as other budget information when decision-makers weigh resource allocations.

- A mixture of output, outcome, efficiency, and other measures should be presented within the budget. Because a number of factors contribute to budget performance, a variety of information may help pinpoint the source(s) of program success or failure.

- Departments and agencies should play a key role in the development and selection of performance measures used in the budget. Managers should not be held accountable for program performance if they are not involved with setting and monitoring performance goals and objectives.

Out of necessity, budgetary decisions are based on factors in addition to program costs and performance. Accordingly, performance measurement should not be viewed as the only tool for resource allocation. If performance measurement is the key to allocation decisions, however, the budgetary process can help to reinforce the use of performance measurement in management and planning functions.

2.3.6 Other Experiences with Performance Measurement

Other areas with experience in the application of performance measurement with potential relevance to transportation planning include education and non-profit organizations.

Education

In an internal decision-making context, performance measurement and evaluation in education are focused on the individual student. Educators, teachers, and administrators rely heavily on the results of standardized and non-standardized achievement tests to evaluate whether an individual student is successfully learning. Average test scores also sometimes provide guidance in evaluating the performance of a particular program or curriculum. As in other fields, education professionals face challenges in developing meaningful performance measures. The debate over the need for, and content of, standardized measures in public education has been at times intense at the federal, state and local levels.

An important issue in measuring educational achievement is the need for standards. The well known system of assigning letter grades to students is an attempt to convey a broad array of quantitative (e.g., test scores) and qualitative (e.g., diligence, improvement, intelligence) characteristics. Yet because there is no standard meaning to these ratings, parents, universities, and potential employers often find letter grades inadequate or inaccurate. The National Council on Educational Standards and Testing has recognized this problem and called for a national voluntary system of standards representing what students should know and be able to do in order to earn certain grades.

In an external evaluation context, educational institutions are often ranked on the basis of standardized test scores or other quantifiable criteria. One example is the annual ranking of U.S. colleges and universities by *U.S. News and World Report* which relies on measures such as student selectivity, faculty resources, research activity, and reputation. In addition to a variety of quantifiable data such as number of faculty or research dollars, this report uses survey techniques to gather data on institutions' reputations.

Comparative Evaluation of Nonprofit Organizations

The comparative evaluation of social programs, health care facilities, and other non-profit organizations is an external evaluation application of performance measurement. Traditionally, such comparative evaluations were made by identifying appropriate performance measures and then listing the corresponding values for each organization in a matrix or other framework. Few attempts have been made to develop a single value or index that can be used to compare one organization to another. One major concern when performing comparative evaluations is accounting for external factors or exogenous variables that affect an organization's output but do not affect input variables.

In the last decade, a cost-effectiveness approach has often been used for comparative evaluation. One technique that is often applied is Data Envelopment Analysis (DEA), a linear programming technique developed in the management science field. DEA is used to measure the relative efficiency of nonprofit organizations. Since neither inputs nor outputs need be expressed in dollar terms, noncommensurate inputs and outputs may be accounted for in the analysis.

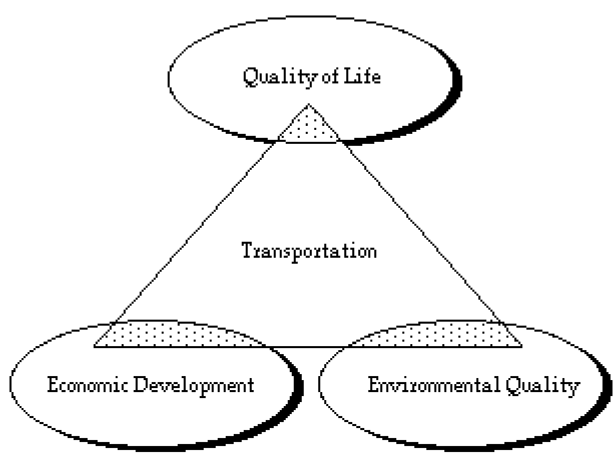
3.0 A Framework for Performance-Based Planning

3.1 Overview

It is important to identify the relationship between goals and objectives and other key elements of the transportation planning process. A fundamental point of departure for performance-based planning is the definition of how transportation systems affect society. This perceived relationship between transportation systems and the functioning of an urban area, for example, becomes a critical foundation for measuring whether the transportation system is "performing" its intended ultimate functions.

Figure 3.1 depicts in much-simplified schematic form the relationship between transportation and three of the major roles often attributed to transportation systems. Transportation is one of the "empowering" factors that allows economic development, environmental quality, and quality of life to exist in an integrated way. Thus, for example, the mobility provided by transportation systems allows access to the employment, social, and other opportunities that provide the basic means of assuring an acceptable quality of life. This same mobility contributes to the overall economic development potential, or competitiveness, of the community. And finally, the provision of mobility is often accompanied by negative impacts to the natural environment, with a resulting impact on quality of life and perhaps economic development potential as well. Thus, the transportation system contributes in some way to each of these three fundamental roles, and also causes some interaction between the three roles.

Figure 3.1 Fundamental Roles of Transportation



The importance of the concept illustrated in Figure 3.1 is that if the underlying functional role of the transportation system is related to achieving some other greater purpose (e.g., economic development) then the related measures(s) of system performance should also reflect this broad purpose. The measures should not solely reflect the more specific transportation function (e.g., mobility) itself. Stated in the parlance of the public sector non-transportation fields we reviewed, the performance measures should reflect the *outcome* of transportation system investments on these fundamental roles, in addition to measuring the *output* of the system itself.

3.1.1 Relationship of Roles to Performance Measures

A second important concept embedded in Figure 3.1 is that performance measures should relate to that intersection of specific transportation functions and the more broad societal role. As has been heard so often in our research, it is important to measure *what we can influence* through investments in transportation. This is suggested by the shaded portions of Figure 3.1, and is best illustrated by example. Again using economic development as the example of a broad societal role for transportation, appropriate performance measures are those which describe the economy in ways that are clearly related to, and influenced by, the transportation system.

It follows that we must also measure that which we can reasonably attribute to some decision we have influenced through our methods. If the performance measures are drawn too broadly, we cannot say with any confidence that our chosen course of action is responsible for the change in the performance measure. For example, assume our broad goal is to enhance local economic activity and competitiveness through transportation investments. A more specific objective might then be to improve the access of employers to labor markets. Examples of poor measures include gross measures of productivity or employment in the local market, which are subject to influence by many external factors, some of them far more significant in their effect than transportation.

An example of a better performance measure would be the "number or percent of businesses with access to adequate labor supply within 30 minutes of the site." Other formulations of this example measure include "number of employable residents within 30 minutes of major employment center" or similar. (Precise definition of "adequate" or "major" is best left to the individual application.) This measure has several important attributes:

- It measures changes in the accessibility of labor which can be attributed at least in part to transportation system investments;
- It is a measure of an element (access to labor) which has a clear linkage to the stated plan goals and objective; and
- It also has a clear linkage to one of the underlying roles of transportation, i.e., economic development.

Such a measure has other desirable attribute described elsewhere in the literature, e.g., it can be measured with observed or synthesized data, it can be made mode-neutral, etc. However, our primary concern here is the fact that it is well connected to the broad strategic goals and roles of the transportation system. This clear linkage is missing in the majority of current implementations of transportation system performance measurement.

Once this relationship between transportation system performance and societal desires is accepted, the relationship between goals/objectives and the rest of the elements of performance-based planning falls more easily into place. This relationship relates to the appropriate performance measures for the stated goals and objectives, to data collection, and to analytical methods. Some further explanation and definition of the different elements is helpful.

3.1.2 Goals and Objectives

Most transportation planning efforts begin with a definition of goals and objectives, which are typically recorded in the official planning documents of the appropriate jurisdiction (e.g., Statewide Transportation Plan, Regional Transportation Plan, etc.) This rational perspective on planning assumes that investment in transportation systems is aimed at achieving some ultimate purpose. Goals and objectives relate to system performance in that they reflect different perceptions of what the transportation system should be achieving. These goals and objectives are often developed through extensive public outreach efforts and thus incorporate a broad community perspective of what elements of system performance are truly important. Understanding different goals and objectives is critical to identifying the different types of performance measures that might be incorporated into the planning process. And, as we described above, it is desirable to become more disciplined in our definition of goals and objectives in order to make them more operational and less ambiguous.

3.1.3 Performance Measures

One of the major changes to transportation planning that has resulted from ISTEA is the requirement for planners to identify and use performance measures in the transportation planning process. Beyond ISTEA, however, there is a growing demand among elected officials, other decision-makers, and planning professionals for greater accountability in the investment of public transportation funds. This sentiment is well documented in other governmental sectors as well as in private industry, and is related to a growing emphasis on the quality of service provided to the users or "customers" of the transportation system. Identification of more goal-specific performance measures is an important precept of greater accountability.

Thus, performance measures are critical elements of a performance-based planning process in that they determine what type of information is fed back into the investment and decision-making processes, and ultimately relate to how "successful" system performance is defined. On the analytical side, performance measures define the type of data that need to be collected to operationalize the performance measures, as well as the type of analytical tools that are necessary to translate data into information and thereby identify system deficiencies and opportunities.

3.1.4 Data

The performance measures selected as part of the planning process must be updated on a periodic basis, thus implying some amount of continuous or periodic data collection. The high cost of ongoing data collection programs is a common and significant concern of many DOTs and MPOs today. System operation-oriented performance measures may continue to rely to a great extent on data collection techniques that have been used for decades, such as traffic counts, travel time studies, travel delay studies, and classification counts.

Broader-defined performance measures are more likely to require spatially allocated socioeconomic information and other indicators of economic development or quality of life. Data on environmental impacts would be focused on the likely consequences of system operation on the natural or man-made environment. In some cases, the data could be surrogate measures (such as VMT) that act as indicators of impact. Intelligent Transportation Systems (ITS) technology is likely to play an important role in future data collection and manipulation strategies required to support a broader variety of performance measures.

3.1.5 Analytical Methods

The analytical methods required to operationalize each type of performance measure will clearly reflect the issues related to that measure and the type of data that are available for input. For example, system operation measures would be most affected by strategies aimed at improving the vehicle or person flow in key corridors. Thus, the analytical methods relevant to this type of strategy might include traffic flow simulation models, capacity and delay modeling packages, and network models. Measures that focus on the relationship between transportation system performance and other societal issues would require a broader range of analytical capability that relates concepts such as mobility and accessibility to specific outputs. Geographic information systems (GIS) could become an important foundation for such analysis in that the spatial allocation of the "benefits" and "costs" of transportation investment will most likely be an important element of system effectiveness. Performance measures relating to externalities would be best analyzed using existing impact models.

■ 3.2 Performance Measurement in the Planning Process

In one form or another, the elements above – goals and objectives, performance measures, data, and analytical methods – are all part of the existing planning process as it is carried out in most jurisdictions. Although the range of performance measures in use in most cases is quite narrow, they are nonetheless part of an existing process. What is new about the performance-based methodology is the *organization* of these elements, the *linkages* between elements in the process, and the presence of an ongoing monitoring process that provides *feedback* on the progress towards goals and objectives.

Figure 3.2 illustrates this point. Goals and objectives derived from the comprehensive planning process are related to the underlying roles of transportation. These goals should in turn be reflected in appropriate performance measures. The measures then determine what data is required and what analytical methods are most appropriate. The data are supplied as input to the analytical methods, which enable the assessment of alternative strategies. The performance measures themselves may be useful in identifying alternative strategies for evaluation, by drawing attention to areas of unacceptable performance.

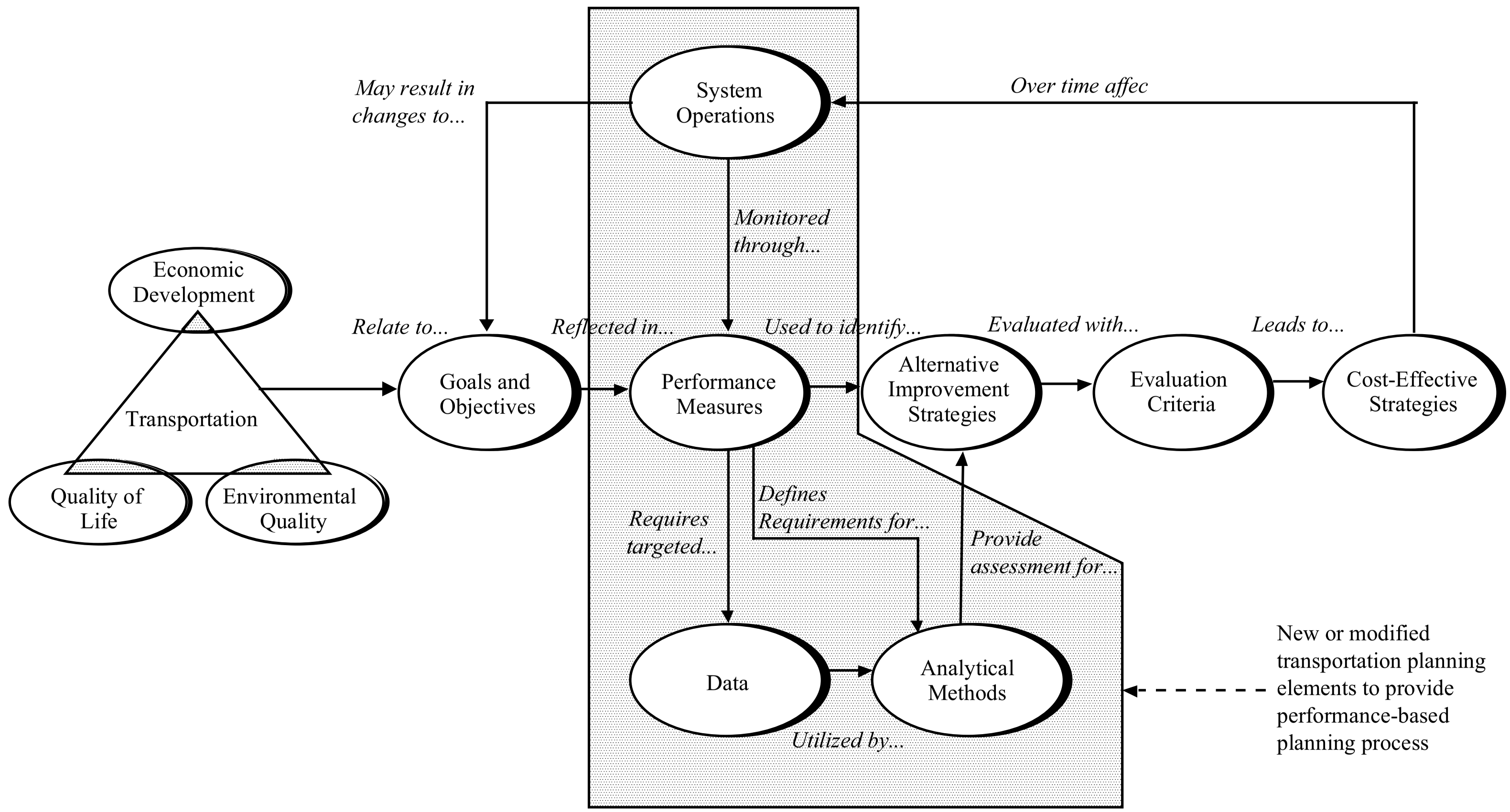
Continuing the description of Figure 3.2, alternative strategies may be assessed with evaluation criteria that are in fact distinct from the performance measures. This accommodates the fact that there can be many more consequences of actions than there are system performance measures. These evaluation criteria will likely cover a large variety of impacts of concern to local decision-makers. The evaluation criteria should, however, be closely related to the defined system performance measures. By so doing, there is a stronger connection between project-level evaluation/selection and system performance measurement. This is one of the defining characteristics of performance-based planning as refined in this study. These evaluation criteria may be more specific to the alternatives evaluated in a given cycle (e.g., may be mode-specific, or place greater emphasis on cost) to allow finer distinctions to be made between alternatives. They may be developed and organized into subsets for application to certain periodic procedures, such as capital budgeting, TIP development, etc.

Strategies which are cost-effective then emerge from the process, which over time will impact system operations. The system operations are monitored by the same performance measures which initially were used to identify and evaluate alternative strategies. This ongoing monitoring process will result in periodic adjustments to goals and objectives, and to the performance measures themselves. Most importantly, it will give a periodic assessment of progress towards longer-term goals and objectives, and towards attainment of the underlying roles of transportation, that is, economic development, quality of life, and environmental quality.

■ 3.3 A Typology of Goals and Objectives

Section 2.0, above, included examples of goals and objectives drawn from state and MPO transportation plans and management systems, as well as useful ideas and examples from other sectors and industries. This research project, however, is focusing on the evolutionary process of what the transportation planning process could look like, given greater attention and discipline towards establishing clear linkages and feedback loops between the elements. As mentioned earlier, a cornerstone of a performance-based planning process is the definition of what is meant by system performance. This quickly leads to the question of, what ultimately are we trying to accomplish with purposeful changes to the transportation system?

Figure 3.2 Elements of a Performance-Based Planning Process



It seems likely that the major transportation issues that will be faced by states and metropolitan areas will not change drastically over the next several years.[1] Thus, the goals and objectives that relate to such things as enhanced economic development opportunities, reduced congestion, etc. will continue to be found in most transportation plans. How we chose to define and monitor progress towards those goals, however, could change substantially. One fundamental shift suggested above is the from an "owner" perspective of system performance to a "user" perspective. A good illustration of this is found in the long-standing professional interest in finding ways to reduce congestion.

Identifying different approaches for measuring congestion has been an important topic in the transportation profession for many years. Most of the measures that were identified almost 40 years ago are still the major measures considered today. These measure the physical ability of the road system to handle vehicular demands, for example, the commonly used volume-to-capacity (v/c) ratio. However, congestion means different things to different groups. For the *operators or owners* of the road system, there are clear operations-based measures which relate performance to traffic volume and speed characteristics, as well as system-based measures which relate traffic levels (utilization) to system capacities. For operations reporting, the desired measures would rely on the traditional data collected in every metropolitan area, e.g., traffic counts, screenline counts, toll counts, boarding counts for transit, etc. For systems monitoring, the measures would need to identify both changes in breadth and depth of congestion, where breadth could be defined as the percent traffic affected, and depth could be the total time (duration) of delay.

For the *users* of the road system, there are different measures which reflect actual trip patterns and trip characteristics and allow comparison to desired trip characteristics. User-oriented monitoring and measurement would identify the differences between system measures and individual measures. For example, change in average travel times for specific origin-destination pairs, taken within a context of known average trip lengths and mode split data for a metropolitan area, permits assessment from the users point of view.

One of the reasons why there is possibly some discrepancy in the results of the congestion studies that have been conducted is precisely this difference between the target market characteristics of the individual trip (e.g., average trip time) versus that of the system/facility (e.g., average speed on a facility.)

In summary, the most commonly utilized performance measures in use today were derived from what, at first glance, appears to be diverse and unrelated groups. Managers have traditionally viewed performance in terms of cost-effectiveness and efficiency. Civil engineers have placed emphasis on levels of service, or facility-based performance monitoring. Systems engineers view queues and delay times as important measures of performance. Service providers have considered scheduling and routing issues as important determinants of transit system performance.

The performance measures which are derived from each school of thought carry with them owners' value judgments as to what the user may perceive as "performance." Fre-

[1] One change which could take place over a fairly short time span with potentially dramatic impact on transportation is a rapid and large increase in petroleum prices.

quently, no direct and concise connection could be defined between the user and the elements being monitored with the performance measure. The monitored elements became a surrogate for the user, and have remained entrenched as current and accepted practice for the planning of transportation systems. The undesired result of this is the tendency to manage towards optimization of performance measures which are not necessarily good representations of performance from the users' perspective.

3.3.1 Components of the Typology

A significant shift is required in the utilization of performance measurement in the planning process. There is a need to more directly incorporate accurate measures of the users' perception of system performance. This will require greater inclusion of measures of system effectiveness, rather than system efficiency alone. As stated in the lexicon of the service industries, more emphasis is required on the outcome of our transportation planning processes and investments, as opposed to the output of those processes and investments.

While measures of output and efficiency have an important role in the overall delivery of transportation services, the tendency has been to default to these measures, and to assume that they reflect what the user wants out of the system. In fact, our research, and in particular our face-to-face discussions with practitioners, suggests that in most cases these measures have become surrogates for the customers' needs, and that all planning and programming activities tend to migrate towards optimization of the measures.

Although there are different ways of classifying goals and objectives for performance-based planning, a particularly useful approach for this project is shown in its most simple form in Table 3.1. The goals and objectives may be classified in three categories: **Efficiency, effectiveness, and externalities,** as follows:

Table 3.1 Example Typology of Goals and Objectives

	Goals and Objectives
Efficiency	Define movement itself; Focus is on system *output*
Effectiveness	Define purpose of movement; Focus is on *outcome* of actions
Externality	Define impact of system construction and operation; Focus is on *external* impact

- Goals and objectives which address **system efficiency** are about *movement itself*. The efficiency of the transportation system relates to those physical characteristics of system operation that correspond to vehicular or person flows. This is the traditional perspective of system performance and encompasses such topics as congestion relief, reduced costs of travel, and improved travel times. There are also many **system efficiency** goals in use which require description of the output of transportation programs in measures such as the number of lane miles resurfaced, the number of revenue boardings, etc. These can be generally labeled efficiency or output goals and objectives.

- In contrast, transportation **system effectiveness** is best defined in relation to what transportation provides to a community, or what is the *purpose* of all the effort and investment. As stated in the service industries, effectiveness is about what one is trying to deliver, or what has been promised to the customer. Examples of such goals include statements such as, the transportation system should provide mobility for all citizens in the community, the transportation system should provide accessibility to economic activities, or transportation services should be provided and financed in an equitable way.

- **Externalities** associated with the transportation system relate to the environmental and societal impacts of system construction and operation. Examples of such externalities particularly germane to transportation include air quality, noise, dislocation of households and businesses, wetlands impacts, and water quality. There are also secondary or indirect impacts associated with the increased development that possibly occurs as a result of enhanced accessibility.

3.3.2 Desirable Attributes of Typology Elements

This classification of different goals and objectives is helpful to understanding the different types of performance measures that might be incorporated into the planning process. These three categories of goals and objectives may be usefully carried through the typology to include performance measures, data, and analytical methods. This helps to ensure that the choice of goals and objectives directly influences the type of performance measures and evaluation criteria selected, the type of data that need to be collected to operationalize these performance measures, the analytical methods that convert this data into information, and ultimately the types of consequences that result from the implementation of strategies and actions.

Table 3.2 illustrates the desirable characteristics of goals and objectives, performance measures, data, and analytical methods, in each of the three categories. For example, appropriate **efficiency** goals would define movement itself, and focus on system output. A corresponding performance measure, therefore, would demonstrate features such as system capacity and utilization. Data must be collected which reflects these system or facility attributes, and the chosen analytical methods must be capable of assessing condition with respect to capacity and utilization. (These are examples of a broad range of possible attributes.)

In the **effectiveness** row of Table 3.2, we see that different attributes should guide the identification and selection of goals, measures, data, and methods. To assess movement towards goals that speak to the *purpose* of actions, performance measures must demonstrate the outcome of actions in terms that system users themselves might adopt. This drives data needs as well, for it is then necessary to chose data that reflect the users' perception of outcome or service level, possibly at the trip level rather than the facility or system level. This requires analytical methods capable of assessing conditions at the trip level, in user-familiar units or terms. Stated another way, the methods must focus on the "intersection" of the user and the system, rather than on the system itself.

Finally, attributes of elements in the **externality** row suggest goals that focus on external impacts; measures then must demonstrate the change in condition, or impact, resulting from action. In this category in particular, a variety of data are required, which are capable of describing environmental or societal resources, and/or which describe features such as public health, welfare, and economics. Analytical methods must now be capable of assessing the intersection of not only the system and the user, but also of the environment.

3.3.3 Examples of Appropriate Typology Elements

Having defined desirable attributes of each of the elements, it is possible to provide examples of goals and objectives, performance measures, data, and analytical methods for each case or category. These examples are not meant to be all-inclusive, but rather to demonstrate the range of possibilities within any given dimension of the typology.

Table 3.3 lists examples which further clarify the distinction between efficiency, effectiveness, and externality. These examples also help illustrate the important relationship across any horizontal row in the table, that is, how identification of goals and objectives should dictate the remaining elements, rather than the reverse. As noted by participants during the regional advisory meetings, it is important to not let the measures, and the availability of certain types of data, drive the process. Goals and objectives should not be skewed to fit the available measures.

Goals and Objectives

Goals and objectives relating to system or facility *efficiency* are most common in use. Typical examples include goals related to reduction of congestion, or provision of facilities and services at a reasonable (aggregate) cost. Congestion reduction objectives may be expressed in a variety of derivative ways, such as **average speed** or **travel time**. In contrast, the *effectiveness* of transportation investments is better tracked through goals and objectives which speak to mobility, accessibility, and reliability. For example, the effect of a system improvement might be to improve the users' **access** to vital services or opportunities. Or, it may reduce the **per-shipment cost** (rather than the aggregate construction and operating cost) for shippers and carriers, or improve the **reliability** of those shipments. These are goals and objectives the user (whether commuter or commercial) can reconcile with their own particular calculus of trip-making decisions and values.

Goals related to *externalities* would include those dealing with air quality, open space or habitat preservation, or safety, to name a few. Another potentially broad goal would relate to **external costs** imposed upon society by transportation decisions. These type of goals bring together the system, the user (and non-user) and the natural environment, and reflect society's desired interaction and tradeoffs between the three.

Table 3.2 Desirable Attributes of Typology Elements

	Goals and Objectives	Performance Measures	Data Collection and Monitoring	Analytical Methods
Efficiency	Define movement itself; Focus is on system output	Demonstrate system capacity and utilization	Reflect system or facility capacity and usage	Assess system and facility condition with respect to utilization and capacity
Effectiveness	Define purpose of movement; Focus is on outcome of actions	Demonstrate outcome in user-oriented measures	Reflect user impact, and perception, at the trip level	Assess intersection between system and user; assess condition from user point of view
Externality	Define impact of system construction and operation; Focus is on external impact	Demonstrate change in impact or condition resulting from actions	Reflect environmental or societal resources; public health, welfare and economics	Assess intersection of system, user, and environment; estimate contribution of transportation system to conditions

Table 3.3 Example Typology Elements

	Goals and Objectives	Performance Measures	Data Collection and Monitoring	Analytical Methods
Efficiency	• Congestion reduction • Travel time • Cost of providing service	• v/c and related capacity measures • Speed and delay related measures	• Vehicle counts • Travel time and speed • Construction/operating costs	• HCM Methods • Simulation models • Demand models
Effectiveness	• Mobility • Accessibility • Trip (or shipment) cost and reliability	• Percent population served by modes • Percent population within defined trip time • Cost per person or ton mile • Standard deviation of trip time	• Spatially-linked demographic data • Trip origins and destinations • Cost of trip inputs • Knowledge of incident frequency	• GIS-linked network models • Statistical sampling and analysis methods
Externality	• Air quality maintenance • Sensitive habitat preservation • Safety of travel	• Vehicle emissions • Acres lost or preserved • System accidents or fatalities	• VMT as surrogate • Project site impact • Accident severity	• Emissions models linked to demand models • Risk analysis • Trend extrapolation

Performance Measures

Efficiency

Again, the traditional approach toward performance measures would focus on system *efficiency* and thus relate to such things as v/c, delay, level of service, and travel time. These measures tend to demonstrate utilization of the facility, or just the capacity of the system or one of its components. Indeed, a review of the performance measures selected by some of the MPOs which have already identified performance measures for their congestion management systems shows a continued emphasis on this type of measure. The regional meetings conducted for this research project revealed that despite the inclusion of more user-oriented goals and objectives in the current ISTEA-influenced statewide and regional plans and management systems, when it comes time to measure the benefit of a given action or strategy, most performance measures in use still focus on efficiency and output.

Effectiveness

A broader perspective on transportation system performance would suggest measures that relate to system effectiveness and externalities, in addition to efficiency. A key challenge is to measure system performance in ways that speak directly to the users' perception of effectiveness. Qualities such as mobility, reliability, and accessibility are frequently cited in planning goals, but less successfully carried forward into operational performance measures. These goals suggest performance measures such as the percent of population reasonably served by specified modes (one measure of mobility); the percent of population within a defined travel time of important opportunities such as employment or vital services (accessibility); or the standard deviation of travel time in an important corridor (reliability.) These example measures all can be operationalized in terms and units that the lay public or commercial transportation system user can understand and incorporate into their own decisions.

Often-cited reasons for the failure to faithfully translate goals and objectives include over-reliance on readily available data and analytical methods, limited resources to operationalize measures, and the inertial tendency for agencies to default to internal measures of service delivery (management performance) rather than external measures of system performance as perceived by the user.

Externalities

Performance measures associated with externalities would be related to the actual impacts of given actions or strategies. Because of the environmental analysis and reporting requirements that have long been in place, the measurement of environmental externalities is further along than that of effectiveness. Data sources and analytical methods have been evolved to a relatively high level. However, the actual measures chosen to describe external impacts could be improved to be more representative of the consumers' (users and non-users) own methods of valuing or assessing the situation. For example, rather than focusing only on emission measures, such as grams/mile or tons/day, conversion of these data to comparative estimates of, for example, number of annual violations of standards, might allow more direct linkage to planning goals and objectives. (The current requirement of the Clean Air Act for non-attainment areas to meet emission standards through reduction in vehicle miles traveled (VMT) is another system performance measure that relates to this externalities category. However, VMT is a surrogate measure, and conveys little meaning to the typical user.)

Other measures, such as acres of habitat (or open space) lost or preserved through alternative actions, may have more direct meaning for the user, and are readily generated with current GIS technology.

Performance Measures for Non-Motorized Travel

The North Central Florida Regional Planning Council's *Gainsville Mobility Plan* features performance measures for not only highways, but for pedestrians and bicycles as well. Pedestrian performance measures relate to sidewalk continuity, crossings and conflicts with vehicles, pedestrian amenities, maintenance of pedestrian facilities, vehicle LOS, and TDM/multimodal support. Bicycle performance measures relate to bicycle facilities provided conflicts with vehicles, speed differential, maintenance, vehicle LOS, and TDM/multimodal support. With these measures, agency staff are better able to assess the costs and benefits to non-motorized modes of travel relative to a variety of investment strategies.

Source: North Central Florida Regional Planning Council. *Gainsville Mobility Plan;* Draft, December 1994.

Data

The selection of performance measures which faithfully reflect the goals and objectives of a system plan will in turn dictate the type of data required to operationalize the measures. Contrary to frequently-observed current practice, the need for data should be determined by what kind of performance is being measured, and not the reverse. Traditionally, the availability of certain types of data has skewed if not outright dictated what kinds of measures would be used to evaluate progress towards goals. For example, the long tradition and relative ease of collecting traffic volume data and travel speed results in an abundance of measures derived from these data, all related to system or facility capacity and utilization, such as v/c, level of service, and cumulative delay.

Thus, efficiency-oriented performance measures rely on such data as traffic counts, travel time studies, travel delay studies, and classification counts. While these data are important to evaluation of system efficiency, they cannot support operationalization of measures which are more directly linked to effectiveness goals. Such data need to more accurately reflect the users' own sensibilities and valuations of system performance, rather than that of operators. Research suggests, for example, that *reliability* of travel time, rather than overall duration of travel, is as or more valuable to users, particularly in public transit and the goods movement industry. Another example is the access provided by the system to different opportunities serving the users' needs.

These measures require data that is not currently collected or estimated by most MPOs or states, such as travel-time deviations based on statistically-significant samples, or average travel time by all modes from typical origins to typical destinations. This latter example of accessibility would rely on spatially-allocated socioeconomic information and other indicators of economic development or quality of life. This is a type of data not historically collected or considered in any significant detail.

Externality data would focus on the impacts of system operation on society and the environment. Again, although there is considerable experience and history in the collection of environmental data, more work needs to be done to improve the degree to which the collected data reflect externality impacts in terms that are meaningful to the public and decision-makers, not just to trained specialists. The probable severity of a transportation-related accident, for example, might be more useful in a decision-making situation the accident rate or annual fatalities,

Analytical Methods

Analytical methods need to be selected to reflect the types of issues associated with each type of performance measure and the type of data available for input. Analytical methods relevant to system *efficiency* might include traffic flow simulation models, capacity and delay modeling packages, and network models. These are relatively common, and are in widespread use in most large metropolitan areas and at the state level.

Effectiveness measures would require a range of analytical capability that permits a wider examination of transportation impacts on society. Geographic information systems (GIS) would allow for the spatial allocation of the “benefits” and “costs” of transportation investments, as well as for readily measuring or projecting the accessibility between people and places, the amount of habitat impacted, etc. Appropriate sampling and analysis methods need to be used to develop better estimates of system reliability and cost of use.

Performance data relating to externalities may be analyzed using existing impact models. However, improvements in the linkage between transportation demand models and emissions models are desirable. There is also an emerging interest in risk analysis as a decision-making tool which fits well the emphasis on user perception and outcome that is fundamental to performance-based planning.

MIS Calls for Enhanced Analytical Tools

A midwestern MPO recently embarked on a Major Investment Study (MIS) of an environmentally and politically sensitive transportation corridor. The public involvement process is extensive, and numerous alternative alignments and modal options will be evaluated. Although several multimodal, system-level performance measures entered into the early project scoping stages, the available regional travel model outputs (link volumes) and derivative measures (volume/capacity ratios, speed and delay estimates) are to be the main source of data for analysis and comparative evaluation of the alternatives. The performance measures initially postulated by the agency cannot be estimated for future alternatives with the available analytical tools, and current data collection programs do not support computation of baseline measures. This example points up the need to evolve analytical methods to keep pace with the information demand created by more aggressive and inclusive public participation programs and other features of the ISTEA era, including performance-based planning.

4.0 Analytical Methods

4.1 Overview

This section is a summarization of the Task 3 technical memorandum, and is focused on evaluation of analytical methods currently available to support performance-based planning, and identification of desirable methodological improvements which will support the development of a performance-based planning process. The information presented here is supplemented in considerably more detail in Appendix C, (under separate cover) which contains the full Task 3 technical memorandum.

We have frequently heard concerns expressed about the ability of public agencies and other transportation-related organizations to collect new types of transportation performance data. In many cases, budgetary constraints limit the amount of resources that can be devoted to the task, and even the ongoing, historic analytical processes are threatened. Agency staff are understandably skeptical about the likelihood of committing resources to new methods of data collection, manipulation, and analysis.

Concern is also expressed about the ability of current data collection and analysis methods to support development and evaluation of performance measures, or to facilitate the integration of these measures into the planning and decision-making processes. The experience to date with multimodal performance measures suggests that many agencies do not currently collect or generate the kinds of data, or possess the analytical tools, necessary to develop a set of robust performance measures, particularly those which address system effectiveness.

4.1.1 Desired Results

This research is intended to help initiate resolution of these concerns. By identifying the types of data that are most likely to support transportation performance measures, agencies may in time be able to incrementally redirect and re-focus their data collection and analysis efforts, without necessarily spending more resources on the product. By anticipating the long-term economies of more automated forms of data collection and analysis, agencies may be able to justify investments in higher-technology solutions that address several needs in addition to just data collection needs.

There are several desired outcomes of this step in the research process. One is to review the currently-practiced methods of data collection, manipulation, and analysis, and to identify the shortcomings of these methods as they relate to support of a performance-based planning process. A second desired outcome is to identify possible improvements to these practices which will provide a better link between the information collected and the analytical requirements of a performance-based process.

Finally, and perhaps most importantly at this stage, it is desirable to point the way for agencies to *incrementally* improve their analytical procedures so that new methods of data collection and analysis may be integrated with existing, more traditional methods. Although in the long run it is probable that analytical methods which are based upon new technology will supplant a significant portion of existing methods, most agencies will experience a protracted period during which the traditional and newer methods must coexist.

4.1.2 Findings

Technology will play an important role in bringing new data to the hands of transportation planners. Particularly in the areas of data collection and manipulation, the general movement towards automated and "intelligent" systems will provide greater access to electronic methods of data sampling and collection, storage, organization, and manipulation. Thus, even familiar types of data which are currently collected may be collected at lower cost, be of higher quality, and be manipulated to provide greater value, with the application of emerging intelligent transportation systems (ITS) technologies and procedures. These emerging systems have the potential to provide the information and communications foundation for a performance-based planning process.

For example, one of the typical shortcomings of a state DOT or MPO data collection effort is the sample size or frequency of sampling. There are certain desirable performance measures which rely upon development of statistically valid distributions, for example, the variance in travel time between defined points in a particular corridor. Current practice often limits the data to a single periodic (e.g., annual) observation, with little or no control over random or systematic fluctuations. Newer technologies will make it cost-effective to sample the same locations frequently, building up valid samples from which more dependable and useful summary statistics can readily be generated.

In the area of data analysis, computer software, rather than data collection hardware, will play an increasingly important role in evaluation of performance data. Many of the potential measures which might be developed to offer a more comprehensive picture of multimodal system performance require analytical capabilities that are not in widespread use today. Examples include demand forecasting models which are more sensitive to system operating conditions, travel costs, and other such variables; and accessibility or land use allocation models which will improve the spatial linkage between travel demand and socioeconomic or demographic data. Finally, methods for analyzing more qualitative "customer satisfaction" data might be made more accessible to transportation planners.

Three types of methods are reviewed in this section:

1. Data collection methods;

2. Methods for data storage, manipulation, and dissemination; and

3. Methods for data analysis and forecasting.

Each of these three sections presents a summary inventory of current methods, capabilities of the identified methods, evaluates the most promising new directions in performance-based planning methods, and identifies improvement actions required to enhance the methods.

A more comprehensive evaluation of the methods, in terms of their spatial focus, temporal focus, planning level of analysis, planning goals addressed, output information, current usage, accuracy, and relative cost range, may be found in Appendix C.

4.2 Data Collection Methods

Our research of state DOTs and MPOs around the country confirmed the critical problem of data collection required to support many of the proposed multimodal performance measures. The resources available for data collection are limited, and the apparent lack of coordination between the existing data collection mandates creates inefficiencies that strain these resources as well as the patience of decision-makers and staff alike.

One of the key opportunities for improvements to data collection procedures lies in the spread of ITS technology to the nation's metropolitan regions, through the Early Deployment Programs as well as through other public and private initiatives. Information that is now gathered through laborious processes may be partially or fully automated through use of automatic detection and recording practices. Equally important, data which has historically been unavailable may soon be more readily assembled in areas where ITS strategies such as automated vehicle identification and advanced public transit systems are deployed.

4.2.1 Inventory of Methods

Current Methods

Current methods of data collection in widespread use which could support development of multimodal performance measures include:

- *Manual Traffic and Transit Surveillance* – On the highway side, this category includes traffic volume counts, spot speed observations, classification counts, aerial photography, videography, and license plate matching. For transit, this category includes boarding and alighting counts, peak load counts, and Section 15 reporting.

- *Manual Vehicle Surveillance* – This category includes floating car studies and the use of instrumented vehicles.

- *Manual Freight and Goods Movement Surveillance* – This category includes weight measurements, shipment records, average fuel consumption rate reports, travel logs, vehicle registration data and inspection records, Census of Transportation, Commodity Flow Survey, National Transportation Statistics Annual Report, Truck Inventory and Use Survey, and shipper logs.

- *User Surveys* – This category includes "home" travel surveys, roadside interviews and origin-destination surveys, onboard transit surveys, panel surveys, travel diaries, focus groups, and customer surveys.

Future Directions

The following data collection methods are emerging and will be increasingly available in the future:

- *Advanced Traffic Management Systems (ATMS)/Traffic Surveillance Technologies* – These ITS technologies collect information about the status of the traffic stream. Technologies in this category include loop detectors, infrared sensors, radar and microwave sensors, machine vision, aerial surveillance, closed circuit television, and acoustic, in-pavement magnetic and vehicle probes.

- *Advanced Traveler Information Systems (ATIS)/Vehicle Navigation and Surveillance Technologies* – These ITS technologies include vehicle navigation technologies, which determine the vehicle position in real time (GPS, LORAN, dead reckoning, localized beacons, map database matching and cellular triangulation); and vehicle surveillance technologies, which collect a variety of information about specified vehicles (weigh-in-motion devices, vehicle identification, vehicle classification, and vehicle location).

- *Payment Systems Technologies* – These ITS technologies not only allow electronic fund transfer between the traveler and the service provider, but also enable vehicle recognition. They include Automatic Vehicle Identification (AVI), smart cards, and electronic funds management systems.

4.2.2 Evaluation of Methods

Limitations of Existing Methods and Opportunities in Future Methods

Table 4.1 summarizes the limitations of existing methods in providing information relative to performance-based planning. It also presents a list of opportunities in new methods to enhance the performance-based planning process.

The most notable limitations of existing data collection methods include:

- Relatively high and labor-intensive operational costs;
- Inability to reflect dynamic fluctuations in traffic;
- Varying degrees of accuracy; and
- Limited incentives for data sharing between public and private interests.

Opportunities in the new methods described include:

- Ability to provide real-time data;
- Lower long-term operational costs (although capital costs are significant);

Table 4.1 Data Collection Methods – Limitations of Existing Methods/Opportunities in Future Methods

Current Procedures and Capabilities	Future Directions/Improvement Actions
Manual Traffic and Transit Surveillance, and Manual Vehicle Surveillance	**ITS/Advanced Traffic Management Systems (ATMS)/Traffic Surveillance Technologies**
• Sporadic data collection practices • Data not reflecting dynamic fluctuations in traffic • Application with semi-accurate results • Limited temporal and spatial representation of traffic.	• Can provide an important source of real-time data • Can replace most manual traffic and vehicle surveillance functions • Individual sensors are primarily deployed through signalized traffic control, ramp metering, and detection programs • A few major urban areas have integrated their ATMS sensors into one traffic operations system where data is being processed in a central location and can be retrieved for planning purposes • Most metropolitan areas have deployed ATMS sensors in many subsystems which are not yet integrated into one system, or do not output MOEs that can be used in performance planning • Seventy U.S. metropolitan areas are currently in the process of planning and deploying integrated traffic management systems
Manual Freight and Goods Movement Surveillance	**ITS/Advanced Traveler Information Systems (ATIS)/Vehicle Navigation and Surveillance Technologies**
• Complex data collection process involving sampling of truck performance and freight shipments • Limited cooperation by private sector; Information on the amount and location of truck trips is kept confidential for competitiveness	• Can replace most manual vehicle and freight surveillance functions, and some of the user survey functions • Can dramatically improve sample size and confidence on data • Would require private sector participation • ATIS technologies are in their early development stage in the U.S. • Privacy issue • Software needs to be developed for retrieving, checking and summarizing information from ATIS technologies • This information will need to be integrated with information from ATMS
User Surveys	**ITS/Payment Systems Technologies**
• Expensive development and application cost could be prohibitive	• Using a combination of electronic readers and smart cards/tags this technology can replace most of the deterministic functions of user surveys (O-D patterns, route selection, travel time selection). Surveys are still needed to assess behavioral travel characteristics • Software needs to be developed for retrieving, checking and summarizing information from ATIS technologies • This information will need to be integrated with information from ATMS • Privacy issue

- Improved accuracy; and
- Improved incentives for public/private participation.

Dimensions of Data Collection Methods

Existing data collection methods produce order-of-magnitude to fairly-accurate results, while future data collection methods produce much more accurate information mainly because of the real-time dimension of ITS technologies, and because of the capability of accumulating more representative samples using ITS technologies. In terms of costs, existing data collection methods have lower development costs and higher application costs than future methods.

In terms of spatial focus, there are few differences between existing and future data collection methods. Certain data collection methods are appropriate for a single level of spatial analysis, while other methods might have multiple applications.

In terms of temporal focus, future data collection methods provide a much wider range of capabilities than existing methods: continuous second-by-second or minute-by-minute information is easily collected using ITS technologies in addition to hourly, daily, and average annual transportation performance information. This finer definition can provide valuable insight into the dynamic nature of traffic and transportation performance and form the basis for a more effective monitoring and management of transportation supply.

Dealing with the Cost of Data Collection

When ISTEA arrived on the scene, like many state and MPO planning agencies, the Colorado Department of Transportation (CDOT) expressed concern that the data required to drive performance measures to be used in their Congestion Management System (CMS) would prove overly costly. In order to simplify their efforts, their staff established three assumptions to help guide them through their performance measurement development process:

"Colorado will **not** expect system performance monitoring data to be at a level of detail sufficient to support the post-implementation evaluation of strategy effectiveness.

The system performance monitoring component of Colorado's CMS will focus on collected data, not synthetic (modeled) data.

Colorado's CMS will focus on traffic congestion issues... To the extent that the transportation planning process wants or needs to deal with "quality" issues, it will do so with modeled data as part of its process. That activity is **not** identified as a component of Colorado's CMS.

With this approach, Colorado stressed an incremental, modular approach to collecting CMS data. They started slowly, building on the base of traffic data CDOT currently had on hand. While not addressing a full range of multimodal measures, CDOT was able to focus on issues that were of greatest interest to them.

Source: Rudy, Steven D. *Congestion Management System: The Early Years and the Colorado Experience,* Institute of Transportation Engineers 65th Annual Meeting, Compendium of Papers, 1995.

4.3 Data Storage and Manipulation

The research, including the 10 case studies of transportation planning organizations and projects, has provided the research team with broad knowledge of current data storage, manipulation, and dissemination efforts underway at the federal, state, regional, and local levels. At the MPO level, for example, many regions are only now moving beyond the experimental phase with geographic information systems (GIS), or geographically-referenced databases. We found significant potential to tap into the organizational and analytical powers of these tools to better support data manipulation and dissemination.

Several emerging measures of effective performance are based upon spatial relationships between the traveling population and the transportation system. Measures such as the percent of population served by transit, or percent of population within a defined travel time of job centers (or other attractions) are important indicators of effectiveness. With the aid of geographically referenced transportation and land use data, these type of measures can be generated not only for observed conditions, but also be used to evaluate alternative future strategies.

As the benefits of improved data storage and manipulation and dissemination methods become more clear, some planning agencies are beginning to focus resources in this area. Michigan DOT, for instance, is making extensive efforts to redesign the "data model" used to support all its management systems. Integration of databases to allow access to many users, elimination of duplicative (and often conflicting) sources of similar data, a reduction in data processing and updating costs, and a careful review of the level, accuracy, and amount of data really necessary to support decision-making, are all objectives.

4.3.1 Inventory of Methods

Current Methods

Current data storage, manipulation, and dissemination methods include:

- *Highway Performance Monitoring System (HPMS) and Highway Economic Requirements System (HERS)* – These methods are statewide and urban area databases of a stratified sample of roadways. They are used to summarize highway conditions; select a set of needed improvements to highways based on minimum tolerable conditions specified by the program user (HPMS) or economic criteria based on benefit-cost analysis (HERS); and estimate the costs and consequences of these improvements.

- *Computerized Databases* – These databases could include information relative to highway, transit, freight, or other transportation system information. They are developed by federal, state, and local agencies for the purpose of planning, budgeting, monitoring, and evaluating the transportation system.

- *Geographic Information Systems (GIS) and Computerized Mapping* – These methods are used to store, organize, display, and analyze geographically-referenced transportation-related data.

Future Directions

The following data storage and manipulation methods are emerging and will be increasingly available in the future:

Advanced Traveler Information Systems (ATIS)/Communications Technologies – ITS communications technologies transmit and receive information from mobile and stationary sources (highway advisory radio, FM subcarrier, spread spectrum, microwave, infrared, commercial broadcasts, infrared or microwave beacons, cellular phones, two-way radio, and two-way satellites).

Interagency Coordination Technologies – These ITS technologies connect traveler-related facilities to other agencies such as police, emergency service providers, weather forecasters and observers, traffic management centers (TMS), transit operators, etc.

Database Processing Technologies – These ITS technologies manipulate, configure, or format transportation-related data for sharing among various platforms. General purpose database software is currently being adapted to transportation needs such as data fusion, maps, and travel services.

Work Scheduling, Reporting, and Inspection Technologies – With these technologies, can combine the data collection and data storage processes into one. These technologies include palm-sized and notebook computers, hand-held portable data entry terminals, bar-code scanners, electronic clipboards, and voice recognition systems.

4.3.2 Evaluation of Methods

Limitations of Existing Methods and Opportunities in Future Methods

Table 4.2 summarizes the limitations of existing data storage and manipulation methods relative to the needs of performance-based planning. It also presents a list of opportunities present in new methods to enhance the process.

At this time, there is significant interest around the country in the development and enhancement of existing technologies and methods for data storage, manipulation, and dissemination. GIS and computerized mapping is where much of the attention is now focused. Although the development and implementation of GIS may tax scarce agency resources, there are notable benefits to these systems, including:

- Potential for integration of micro- and macro-scale analytical techniques;
- Ability to provide geographically-referenced indicators ("number of employees within 10 miles of downtown"); and
- Improved graphical representation of transportation-related information.

Table 4.2 Data Storage, Manipulation, and Dissemination Methods – Limitations of Existing Methods/Opportunities in Future Methods

Current Procedures and Capabilities	Future Directions/Improvement Actions
Computerized Databases (including Highway, Transit, and Freight Databases)	
• Database management systems are often incompatible with one another, impeding the efficient and timely exchange of information	• Coordinated and integrated approach to database system development and use will make better use of shared information and will help coordinate decisions • Emerging technologies can enable improved data acquisition (using ITS) and locational-based processing, retrieval, and display of information (using GIS) in support of database systems • Innovative attributes of ITS databases include real-time data processing, data fusion, and expert systems that perform initial screenings of traffic control actions • Development and maintenance of ITS databases can be partly funded by the private sector that could sell real-time traffic information, or business directories/"yellow pages" of service information • Only a few major metropolitan areas in the U.S. have developed embryonic traveler information databases • Federal and state agencies are currently facilitating the development/coordination of travel databases
GIS and Computerized Mapping • GIS provides for the integration of micro- and macro-scale analytical techniques • GIS allows for the visualization of changes over time • Development and implementation of GIS may be complex, time-consuming and costly for those agencies who do not already use it • The FHWA is currently conducting the "Geographic Information System-Transportation ISTEA Management Systems Server Net Prototype Pooled Fund Study" to address the management and monitoring systems as well as the statewide and metropolitan transportation planning requirements of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA).	• As ITS evolve, there is an increasing integration with GIS to develop and operate geographic user interfaces at Traffic Management Centers for traffic surveillance, and for use in Advance Traveler Information Systems, In-Vehicle Information Systems, and Route Guidance **Technologies for work scheduling, reporting and inspection** • This equipment can be used in conjunction with a distance measuring instrument or a GIS receiver in order to attach location tags to data collected in the field • These technologies can significantly reduce laborious and time-consuming field data collection • These technologies can also provide quick access to the transportation system database

Table 4.2 Data Storage, Manipulation, and Dissemination Methods – Limitations of Existing Methods/Opportunities in Future Methods (continued)

Current Procedures and Capabilities	Future Directions/Improvement Actions
	ITS/Advanced Traveler Information Systems (ATIS)/Communications Technologies • ITS communications technologies facilitate the dissemination of information on real-time traffic performance, and real-time traffic control measures • There is little compatibility in ITS communications technologies currently used in the U.S. Communications Standards are currently being developed by the federal government • These technologies are in their early deployment stage in the U.S. **ITS/Inter-Agency Coordination Technologies** • Interagency coordination is an increasingly important function for monitoring, planning budgeting, evaluating, and implementing real-time traffic control actions • Federal and state agencies are currently working towards catalyzing public/private and interagency institutional relationships • Regional interagency coordination is currently starting at major urban areas around operating traffic management centers

Additional benefits lie in future methods, including:

- More efficient links to data collection process, thereby reducing labor costs in data input;
- Greater incentives for private sector involvement (with ITS technologies), which will enhance the content and availability of stored data; and
- Potential for improved data sharing among transportation and non-transportation agencies.

Dimensions of Data Storage Methods

The planning horizons for existing methods for data storage, manipulation, and dissemination focus on medium- and long-term planning primarily because of the level of effort involved in developing and maintaining a database. Future automated databases, however, are more likely to be integral parts of short-term transportation control strategies that can also be used in medium- and long-term planning.

Further, the goal of improved customer service will be better served using future methods for data storage, manipulation, and dissemination because ITS technologies provide better tractability and accountability related to the individual customer/traveler. For example, customized real-time real-location traffic information can be provided to a truck that is equipped with a GPS transponder and a communications system; only general traffic information is currently disseminated using the traditional highway advisory radio technology.

Widely used existing methods for data storage, manipulation, and dissemination include traditional databases, HPMS, and HERS, while the use of GIS is growing. The use of future methods is limited primarily because ITS deployment is currently preoccupied with deployment of hardware rather than developing software or value-added services.

Existing data storage, manipulation, and dissemination methods produce order-of-magnitude to fairly-accurate results, while future methods produce much more accurate information mainly because of the real-time dimension of ITS technologies, and because of the capability of accumulating more robust and representative samples using ITS technologies. In terms of costs, future methods have similar development costs and lower application costs than existing methods. However, prerequisites to ITS methods for data storage, manipulation, and dissemination include deployment of traffic monitoring hardware and integration of roadside hardware with data storage and dissemination systems.

Future data storage, manipulation, and dissemination methods have the potential to be more comprehensive than existing methods in terms of spatial focus. In terms of temporal focus, future methods provide a much wider range of capabilities than existing methods: continuous second-by-second or minute-by-minute information will be stored, manipulated and disseminated using ITS technologies in addition to hourly, daily, and average annual transportation performance information. Thus, the dynamic nature of traffic and transportation performance will be taken into account in the fine-tuning of transportation supply which in turn will be able to address both recurrent and incident-related congestion.

Urban Goods Movement and the 'Dependable LOS'

A case study conducted for the San Francisco Bay Area Metropolitan Transportation Commission (MTC) points out the importance of dependability of the transportation system to trucking operations which are vital to the economic health of the region. The productivity of companies such as United Parcel Service and Consolidated Freightways hinges on the ability to avoid peak congestion, with most local distribution activities taking before or after the peak commute periods. Thus, the predictability of freeways and arterials during the midday and the "shoulders" of the peak period is critical to these companies. System reliability is deemed to be more important than top operating speed to the efficiency of goods movement within the urban area.

Conventional utilization and efficiency measures are inadequate to identify the contribution of a reliable system to the economic well-being of the region. The concept of a "Dependable Level of Service" on principal truck routes has been proposed to fill this gap. Such a measure will require real-time traffic surveillance to monitor and manage traffic flows, as well as the analytic capability to develop valid statistical measures from the data. In the MTC region, Caltrans' Traffic Operating System (TOS) will eventually provide this capability on freeways. However, because the dependability of conditions on select arterials can be as important for efficient goods movement as on adjacent freeways, it will be desirable to extend this kind of monitoring to the arterial streets as well. Such a system could be used to enhance the reliability of arterial transit bus service as well.

The MTC study concludes that monitoring and managing the off-peak dependability of the system is critical to efficient goods movement. The various ITS strategies evaluated in this NCHRP report are well suited to the particular analytical requirements of this type of performance measurement.

Source: David W. Jones, Intermodal Performance Measures for the Bay Area Transportation System, Draft Report, December 1994.

4.4 Data Analysis and Forecasting Methods

Much of the value in improved data collection, manipulation and evaluation methods lies in the resulting improvement in descriptive analysis. Certainly, using performance measures to report on the current condition of the transportation system is a valuable improvement to the planning process. However, it will always be desirable to generate better estimates of *future* activity and performance, in order to support decisions related to significant investment strategies, regulatory policies, etc.

The research highlighted the limited ability of many traditional forecasting methods to generate the kind of data needed to support more robust, multimodal performance measures. The over-reliance on facility utilization measures such as volume to capacity (V/C) ratio and transit patronage has led to a generation of forecasting tools which are unable to produce reliable indicators of broad, multimodal system performance, and which do not adequately support tradeoff decisions between alternative modal strategies.

The research also pointed to the potential benefits of linking demand forecasting methods to both the databases and to exogenous models used for various purposes. There are opportunities to take greater advantage of the various components by linking them more directly. For example, a GIS database can be a very powerful tool for organizing and presenting the results of multiple alternative analyses. This same method in turn provides better data for improved forecasts in subsequent iterations. Finally, more direct and uniform linkage to exogenous analytical tools, such as emissions inventories, will improve the ability to generate measures of environmental performance.

4.4.1 Inventory Of Methods

Current Methods

Current data analysis and forecasting methods include:

- *Sketch Planning Techniques* – These techniques include sketch planning demand models, systematic analysis and transfer of empirical data, quick-response travel estimation techniques, level of service (LOS), V/C ratio, and vehicle volume and speed estimation procedures.
- *Macroscopic Simulation Models* – These traffic models are based on deterministic relationships developed through research on highway capacity and traffic flow. The simulation for a macroscopic model takes place on a highway section-by-section basis rather than on an individual vehicle basis. Typical software packages include TRANSYT–7F, CORFLO, and FREQ.
- *Microscopic Simulation Models* – These traffic models simulate the movement of individual vehicles, based on theories of car-following and lane-changing. Typically, the model simulates a statistical distribution of vehicles that enter the transportation network and then tracks them through the network on a second-by-second basis. Typical software packages include NETSIM, FRESIM, and INTEGRATION.
- *Land Use Allocation Models* – These models reflect the effects of the transportation system (i.e., effects on accessibility, economic development potential, etc.) on the type spatial distribution of future development.
- *Travel Demand Models* – Traditional travel demand models follow a four-step process, including trip generation, trip distribution, mode choice, trip assignment, and activity–based models. A number of software packages can be used to implement this process, including TRANPLAN, MinUTP, and EMME/2.
- *Freight and Goods Movement Models* – These methods include trend analysis, freight network models, and freight transportation demand models. Trend analysis uses historical growth rates for certain key markets, and projects these growth rates into the future, modified by correction factors reflecting competitive conditions, macroeconomic environments, and projections of technological efficiency improvements. Freight network models can handle a large number of freight modes, network links, and nodes, and can contain explicit mode choice algorithms based on minimization of cost and time by mode and route. Freight transportation demand models are similar to network models, although they differ in that demand models explicitly estimate behavioral relationships such as mode and route choice.

- *Impact Models* – These models are used to estimate emissions, fuel consumption, and safety impacts of transportation improvements. Typical software packages include MOBILE and EMFAC.

Future Directions

The following data analysis and forecasting methods are emerging and will be increasingly available in the future:

- *Traffic Prediction Models* – These ITS technologies can be used to predict future traffic characteristics based on real-time information. Algorithms under development include real-time traffic prediction and traffic assignment.

- *Traffic Control Models* – These ITS-related models relate to the real-time control of traffic. Algorithms under development include optimal control and incident detection, and the mutual effects of these processes on one another.

- *Routing Models* – These ITS-related models relate to the routing of vehicles, including the generating of step-by-step driving instructions to a specified destination. Algorithms under development include the scheduling of drivers, vehicles, and cargo; route selection; commercial vehicle scheduling; and route guidance.

4.4.2 Evaluation of Methods

Limitations of Existing Methods and Opportunities in Future Methods

Table 4.3 summarizes the limitations of existing forecasting methods in providing information relative to performance-based planning. It also presents a list of opportunities in new methods to enhance the performance-based planning process.

At this time, there are notable gaps between the abilities of existing tools. Sketch planning techniques only produce order-of-magnitude results, which lose utility as the planning process moves beyond its initial stages. Simulation models are successful in estimating operational changes in traffic flow such as delay, speed, and queuing, but do not consider the trip generation, trip distribution, mode choice, and route choice in system evaluation. Conversely, traditional four-step travel demand models are generally unable to incorporate the effect operational changes into their estimates of generation, distribution, mode choice, and route choice.

Future methods will seek to not only bridge these gaps, but to improve the depth and breadth of forecasts of transportation system performance. Improvements include:

- Incorporation of trip generation, trip distribution, and mode choice in simulation models;

- Enhancements/modifications to traditional four-step process, including peak spreading, dynamic assignment, representation of traveler information, trip chaining, sensitivity to emissions and fuel consumption procedures, and non-motorized travel; and

Table 4.3 Data Analysis and Forecasting Methods – Limitations of Existing Methods/Opportunities in Future Methods

Current Procedures and Capabilities	Future Directions/Improvement Actions
Sketch Planning Analysis Techniques	
• Sketch planning techniques produce only order-of-magnitude results with limited accuracy • These techniques can play a valuable screening role during the early phases of the analysis	• Enhancements include post or parallel processors such as time-of-day models, parking choice models, etc.
Macroscopic and Microscopic Simulation Models	
• Traffic simulation models are successful in accurately estimating changes in traffic operational characteristics such as delay, speed, and queuing • Traffic simulation models do not consider trip generation, trip distribution, mode choice, and major route choice in their evaluation of changes in transportation systems	• Incorporate trip generation/trip distribution/mode choice in the simulation process • Enhancement towards real-time information and modeling of vehicle routings and how drivers react to changing conditions • Explicitly differentiate and represent informed (real-time information) and uninformed (historical information only) drivers.
Regional Travel Demand Models	
• Evaluating changes in transportation systems and operations requires specific analytical capabilities, such as the consideration of trip generation, trip distribution, mode choice, major route choice, and the representation of traffic flow in a network presently found only in the structure of a travel demand model • Travel demand models have only limited capability to accurately estimate changes in traffic operational characteristics such as delay, speed, and queuing	• Integration of GIS capabilities allows calculation of "accessibility" measures which are sensitive to land use policy or actions • Improved forecasting of speed, delay and queuing • Peak spreading • Dynamic assignment • Representation of traveler information • Enhanced sensitivity of emissions and fuel consumption procedures • Modeling trip chaining behavior • Mode choice modeling improvements • Modeling non-motorized travel • Linked regional/simulation models - Full integration of travel demand models and simulation models into a single software - Prediction of travelers' response to information - Also see desired capabilities and improvement actions in travel demand models and simulation models

Table 4.3 Data Analysis and Forecasting Methods – Limitations of Existing Methods/Opportunities in Future Methods (continued)

Current Procedures and Capabilities	Future Directions/Improvement Actions
Land Use Allocation Models	
• It is very costly to develop and calibrate a land-use allocation model	• Linkage to the travel demand modeling process will lower the development cost
Freight and Goods Movement Models	
• A "Quick Response" Freight Manual is currently under development by the FHWA	• Many of the factors influencing freight demand cannot be fully quantified. Incorporation of the effect of these factors into freight forecasts requires judgment.
Impact Models	
• The most significant weakness of current emissions and fuel consumption models is that they do not take into account differences in vehicle operating mode (acceleration, deceleration, cruising, idle)	• Develop emission models and emission rates sensitive to vehicle operating mode (ongoing) • Develop accident prediction models sensitive to levels of congestion and to the presence of another accident
	ITS/Traffic Prediction Models
	• These models will provide the backbone for real-time traffic information • These models require development of behavioral traffic prediction algorithms that estimate drivers' reaction to changing traffic conditions • These models require development of corrective feedback mechanisms to perform frequent reality checks. • Incorporation of mode choice and trip generation in ITS traffic prediction models.
	ITS/Traffic Control Models
	• Inputs/outputs of these models can be very useful in performance-based planning. • Algorithms will need to be developed to aggregate model inputs/outputs so that they become useful in the planning process
	ITS/Routing Models
	• Routing models will need to be linked with Traffic Prediction models and Traffic Control models

- Use of real-time modeling of vehicle routings to more accurately predict future travel characteristics.

Dimensions of Data Analysis Methods

Historically, transportation analysis and forecasting tools were developed to model performance in distinct transportation subnetworks (freeways, arterials, corridors, etc.) and in distinct transportation subsystems (highway, transit, freight). Typically, these transportation subnetworks and subsystems have distinct operational characteristics that were reflected in the development of analytical and forecasting tools. This is one reason for the limited applicability of analytical and forecasting tools across transportation modes.

The planning horizons for existing methods for data analysis and forecasting range from short- to medium- to long-term. ITS data analysis and forecasting tools, however, focus on short-term planning horizons since they are integral parts of short-term transportation control strategies. Historical information on system performance however, can be used in medium- and long-term planning.

The goal of improved customer service will be better served using ITS methods for data analysis and forecasting because some ITS short-term forecasting tools focus on the individual customer/traveler. For example, ITS routing models will provide step-by-step driving instructions to a traveler-specified destination. Similarly, in the area of freight transportation these models will assist in the scheduling of drivers, vehicles, and cargo taking into account real-time traffic conditions.

Widely used existing methods for data analysis and forecasting include sketch planning analysis techniques, regional travel demand models, and impact models; there is a growing use of simulation models, while there is limited use of land use models, and freight and goods movement models. The use of "future" ITS methods is limited primarily because ITS deployment is currently preoccupied with deployment of hardware rather than developing software or value-added services.

Existing data analysis and forecasting methods produce order-of-magnitude to fairly-accurate results, while future methods produce much more accurate information mainly because of the real-time dimension of ITS technologies, and because of the capability of accumulating more robust and more representative samples using ITS technologies. In terms of costs, future analysis and forecasting methods have similar development costs and application costs to existing methods. However, prerequisites to ITS methods for data analysis and forecasting include the deployment of traffic monitoring hardware, the integration of roadside hardware with data storage and dissemination systems, and the development of ITS databases.

A review of existing data analysis and forecasting methods shows that certain methods are appropriate for a single level of spatial and/or temporal analysis, while other methods might have multiple applications. Future data analysis and forecasting methods focus on real-time or near-real-time performance to produce optimal traffic control and to provide customer-specific routing information.